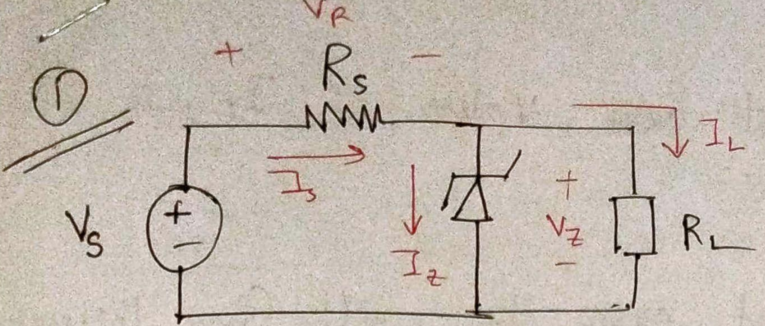
①



The Zener diode is specified as

$V_{Z_0} = 3V$

$r_Z = 0\Omega$

$I_{ZK} = 1mA$

The load current can vary from 0mA to 50mA.

The source has a nominal value of 5V and can vary ±10%.

ⓐ Find $V_s(min)$, $V_s(max)$, $I_L(min)$, $I_L(max)$

<u>Soln</u>: 10% of 5V = 0.5V

$\therefore V_s(min) = 5 - 0.5 = 4.5V$

$V_s(max) = 5 + 0.5 = 5.5V$

$I_L(min) = 0$ mA

$I_L(max) = 50mA.$

(b) What is the worst case values of I_L, I_Z and V_S?

Soln: In worst case, I_{ZK} will flow through the zener diode. [If the current falls below this, the regulation will not be maintained]

KCL $\Rightarrow$ $I_Z = I_S - I_L$

and $I_S = \dfrac{V_S - V_L}{R_S}$

So, I_Z is minimum when I_L is maximum and V_S is minimum.

$\therefore$ Worst case $\Rightarrow$

$I_L = I_L(max) = 50mA$

$I_Z = I_Z(min) = I_{ZK} = 1mA$

$V_S = V_S(min) = 4.5V$

(c) For worst case, what is the value of I_S?

Soln: $I_S = I_Z + I_L = 50 + 1 = 51mA.$

~~(d) For worst case,~~

(d) For worst case, what is the value of V_S?

Sol^n: In worst case scenario, the zener diode will barely maintain its voltage.

~~So $V_L = V_{Z0}$~~

So, $V_L = V_Z = V_{Z0} + I_Z r_Z = 3V.$

$\therefore V_S = V_S - V_L$

$= 4.5 - 3$

$= 1.5V$

(e) Find the value of R_s, for which the zener diode maintains regulation in worst case scenario.

Sol^n: $R_s = \dfrac{V_S}{I_S} = \dfrac{1.5}{51} \approx 30\,\Omega.$

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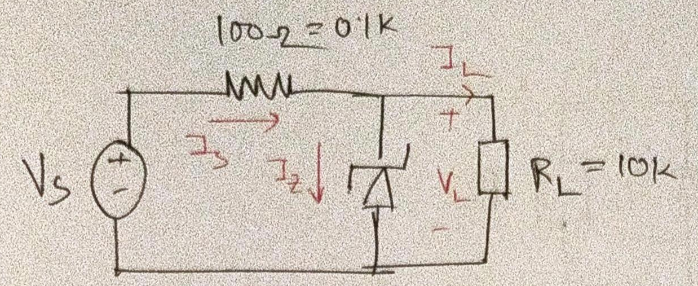


Zener diode specification: $V_{Z_0} = 3\,V$

$r_Z = 0\,\Omega$

$I_{ZK} = 1\,mA.$

Find the minimum value of V_s for which the Zener diode maintain its regulation.

Sol^n: In worst case scenario, $I_Z = I_{ZK} = 1\,mA.$

$\therefore\ V_L = V_Z = V_{Z_0} + I_Z r_Z = 3V.$

$\therefore\ I_L = \dfrac{V_L}{R_L} = \dfrac{3\,V}{10\,k\Omega} = 0.3\,mA$

$\therefore\ I_S = I_Z + I_L$ (KCL)

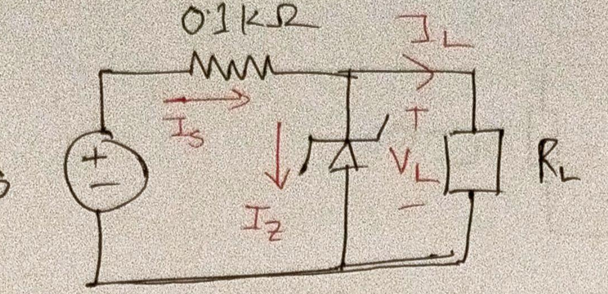
$= 1.3\,mA$

$I_s = \dfrac{V_s - V_L}{0.1\,k} = 1.3\,mA$

$\Rightarrow \dfrac{V_s - 3}{0.1\,k} = 1.3\,mA$

$\Rightarrow \boxed{V_s = 3.13\,V}$ $\therefore \boxed{V_s\,(min) = 3.13\,V}$

(3)



Zener diode specification: $V_{Z0} = 3V$,

$r_Z = 0\Omega$

$I_{ZK} = 1mA$

The source V_S has a nominal value of 5V and can vary $\pm 10\%$.

Find the worst case/minimum value of R_L so that regulation is maintained.

Solⁿ: In worst case, $I_Z = I_{Z(min)} = I_{ZK} = 1mA$

$$V_L = V_Z = V_{Z0} + I_Z r_Z = 3V$$

In worst case, $V_S = V_{S(min)} = 5 - 10\% = 5 - 0.5 = 4.5V$

$$\therefore I_S = \frac{V_S - V_L}{0.1K} = \frac{4.5 - 3}{0.1K} = 15mA$$

$$\therefore I_L = I_S - I_Z \text{ [KCL]}$$
$$= 15 - 1$$
$$= 14mA.$$

$$\therefore \boxed{R_L = \frac{V_L}{I_L} = \frac{3V}{14mA} \approx 214\Omega}$$