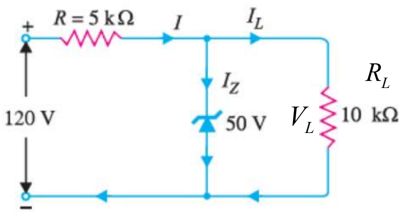
# General Sir John Kotelawala Defense University

## Basic Electronics

## Tutorial 2 – Zener Diodes

## Question 1




Find

(i) the output voltage $V_L$ .

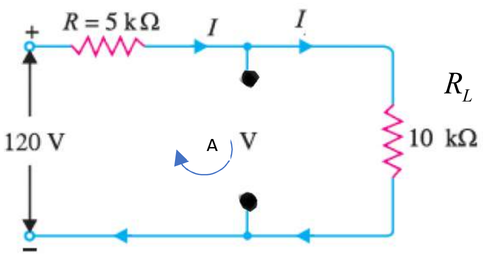
(ii) the voltage drops across series resistance $R$

(iii) the current through Zener diode $I_L$ .

**Solution :**

**In order to answer this question first we have to check whether the voltage across the Zener diode is greater than 50v.**

**Let's find it first. For that let's consider the voltage across the Zener diode as *V* as shown in the following diagram.**




Apply KVL across A,

$V_s = R \times I + R_L I$

$$I = \frac{V_s}{R + R_L}$$

*Voltage* accross the load resistor $R_L$

$V = R_L \times I$

$$I = \frac{V}{R_L}$$

*Then*,

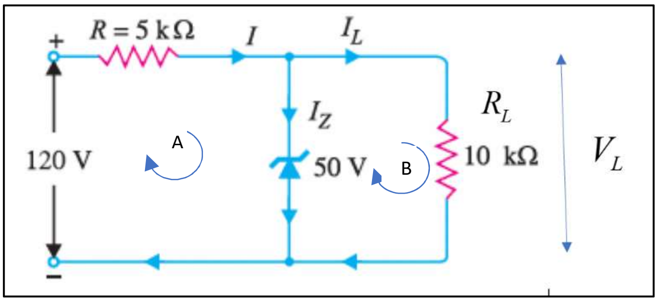
$$\frac{V}{R_L} = \frac{V_s}{R + R_L}$$

$$V = \frac{V_s R_L}{R + R_L} \quad \rightarrow \quad (1)$$

substituting $V_s, R, R_L$ values

$$V = \frac{120 \times 10 \times 10^3}{5 \times 10^3 + 10 \times 10^3} = 80v$$

The voltage across the Zener diode is more than 50v. Therefore, it is functioning.




Apply KVL across A,

$$120 = 5 \times 10^3 I + 50$$

$$I = 70 / 5 \times 10^3 = 14mA$$

Voltage accross the load resistor $R_L$ is $50v$. Where $V_L = 50v$.

*So*,

$$50 = R_L \times I_L$$

$$I_L = \frac{50}{10 \times 10^3} = 5mA$$

Where I=$I_L + I_Z$

$$then,\ I_L = 14mA - 5mA = 9mA$$

The voltage across the resistor $R$ $\mathrm{V}_R$ is

$$\mathrm{V}_R = \mathrm{I}R$$

$$\mathrm{V}_R = 14 \times 10^{-3} \times 5 \times 10^3 = 60v$$

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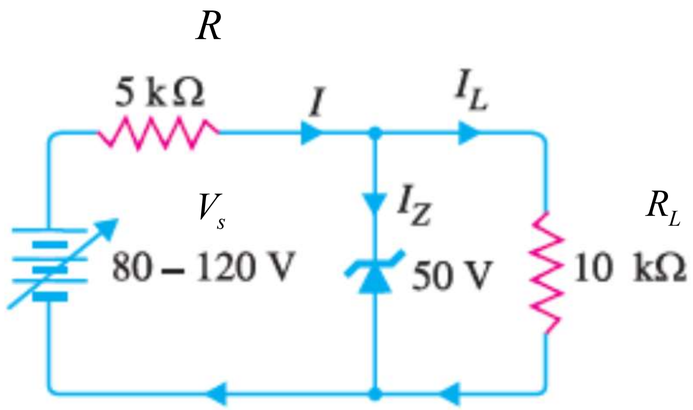
Question 2




Find the maximum and minimum values of Zener diode current.

**Solution :**

**In this circuit the input voltage range between 80 to 120 v.**

**This means at 80v input, the circuit has the minimum current flow and at 120v it flows the maximum current.**

**Firstly, let's check whether the Zener diode is functioning. For that let's check the voltage across the Zener diode similar in Question 1 using equation (1).**

*Then*

$$V = \frac{V_s R_L}{R + R_L} \quad \rightarrow \quad (1)$$

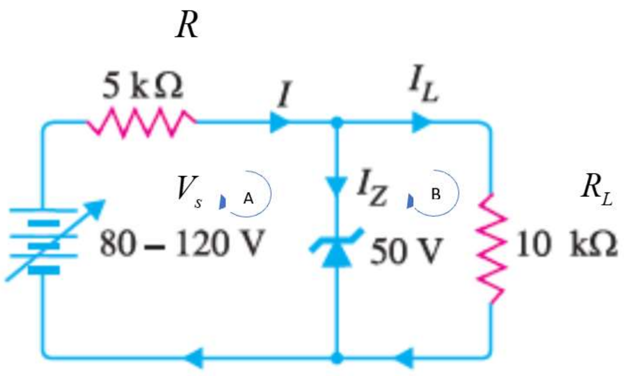
substituting $R, R_L$ values when $V_s = 80v$

$$V = \frac{80 \times 10 \times 10^3}{5 \times 10^3 + 10 \times 10^3} = 53.33v$$

substituting $R, R_L$ values when $V_s = 120v$

$$V = \frac{120 \times 10 \times 10^3}{5 \times 10^3 + 10 \times 10^3} = 80v$$

The voltage across the Zener diode is more than 50v. Therefore, it is functioning for both minimum and maximum input values.




When $V_s = 80v$,
apply KVL across A
$80v = 5\times10^3 \times I + 50v$
$I = 6mA$
apply KVL across B
$50 = 10\times10^3 \times I_L$
$I_L = 5mA$
So $I_z(\min) = I - I_L = 1mA$

When $V_s = 120v$,
apply KVL across A
$120v = 5\times10^3 \times I + 50v$
$I = 14mA$
apply KVL across B
$50 = 10\times10^3 \times I_L$
$I_L = 5mA$
So $I_z(\max) = I - I_L = 9mA$

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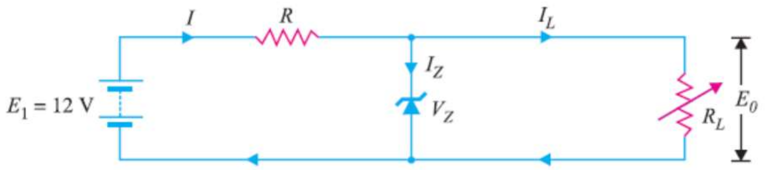
## Question 3

A 7.2 V Zener ($V_Z$ = 7.2v) is used in the circuit shown in below and the load current ($I_L$) is to vary from 12 to 100 mA. Find the value of series resistance R to maintain a voltage of 7.2 V across the load ($R_L$). The input voltage is constant at 12V and the minimum Zener current is 10 mA.




**Solution :**

**In this circuit the input voltage is 12 v and current across the load ($I_L$) is between 12 mA and 100 mA.**

**When the minimum Zener current of 10mA flows through the Zener diode the maximum load current of 100mA flows across the load.**

*Therefore,*

$$E_1 = IR + Vz \quad \rightarrow (1)$$

where $I = I_L + I_Z$

$$I = 100\times10^{-3} + 10\times10^{-3} = 110mA$$

substituting $I, E_1, V_Z$ values in (1) then

$$R = \frac{12-7.2}{110\times10^{-3}} = 43.63v$$

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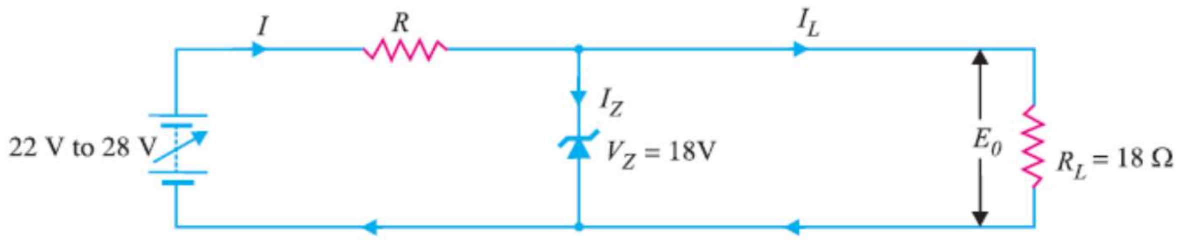
## Question 4

The voltage across the load stays at 18 V as long as $I_Z$ is maintained between 200 mA and 2 A with a Zener diode where $V_Z = 18$ V. Find the value of series resistance R so that $E_0$ remains 18V while input voltage $E_i$ is free to vary between 22 V to 28V.




**Solution :**

**In this circuit the input voltage is is between 22 V and 28V and current across the Zener diode $I_Z$ is 200 mA and 2 A.**

**The Zener current will be minimum (i.e. 200 mA) when the input voltage is minimum (i.e. 22 V).**

$$Where\ V_Z = I_L R_L$$

$$I_L = \frac{18}{18} = 1A$$

$$Also\ I = I_L + I_Z$$

$$I = 1 + 0.2 = 1.2A$$

$$Further,$$

$$E_i = IR + V_Z$$

$$22 = 1.2R + 18$$

$$R = 3.3\Omega$$