

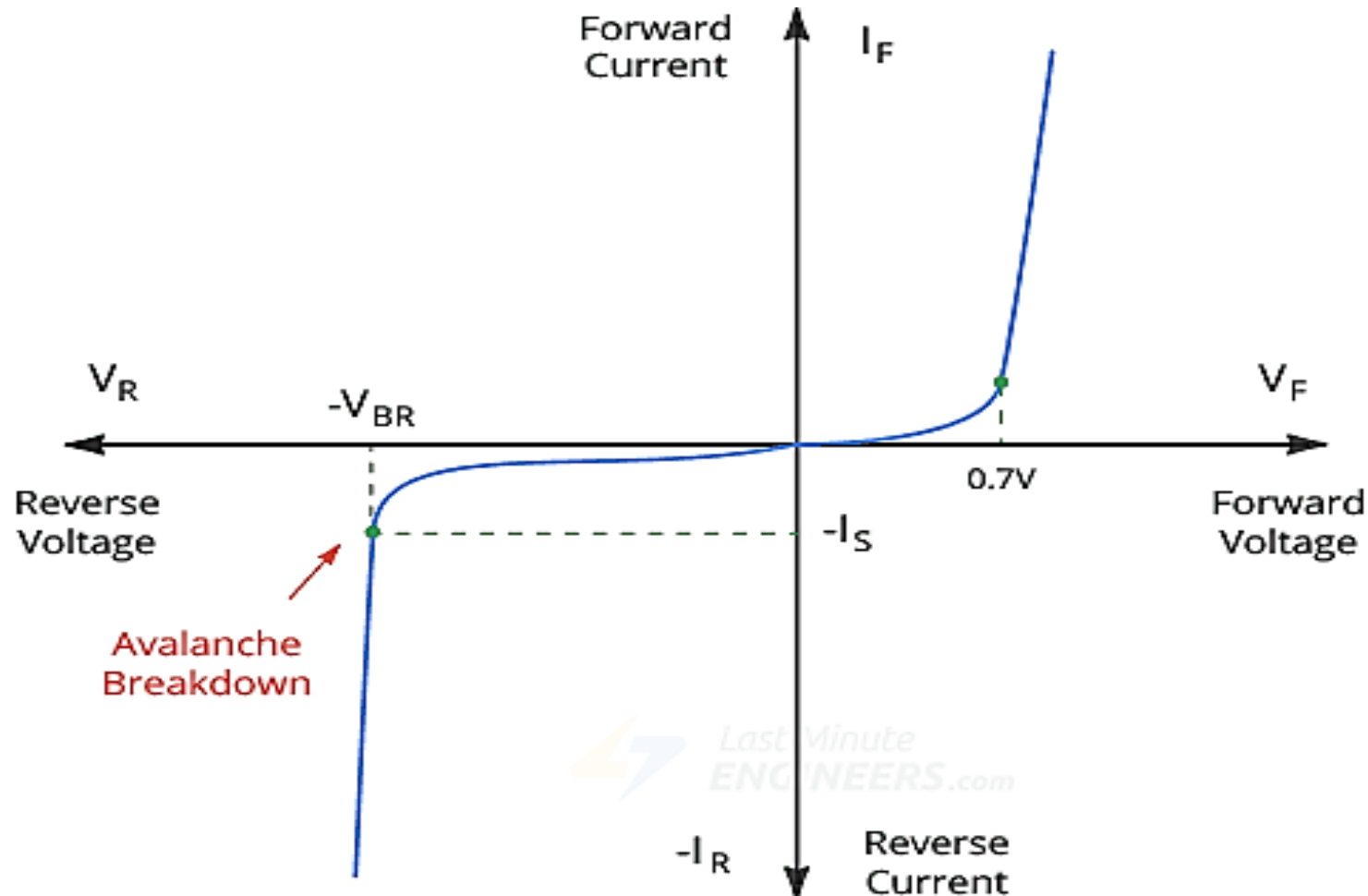
Electronic Devices

Lecture 9 **Zener Diode**

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Zener Diode

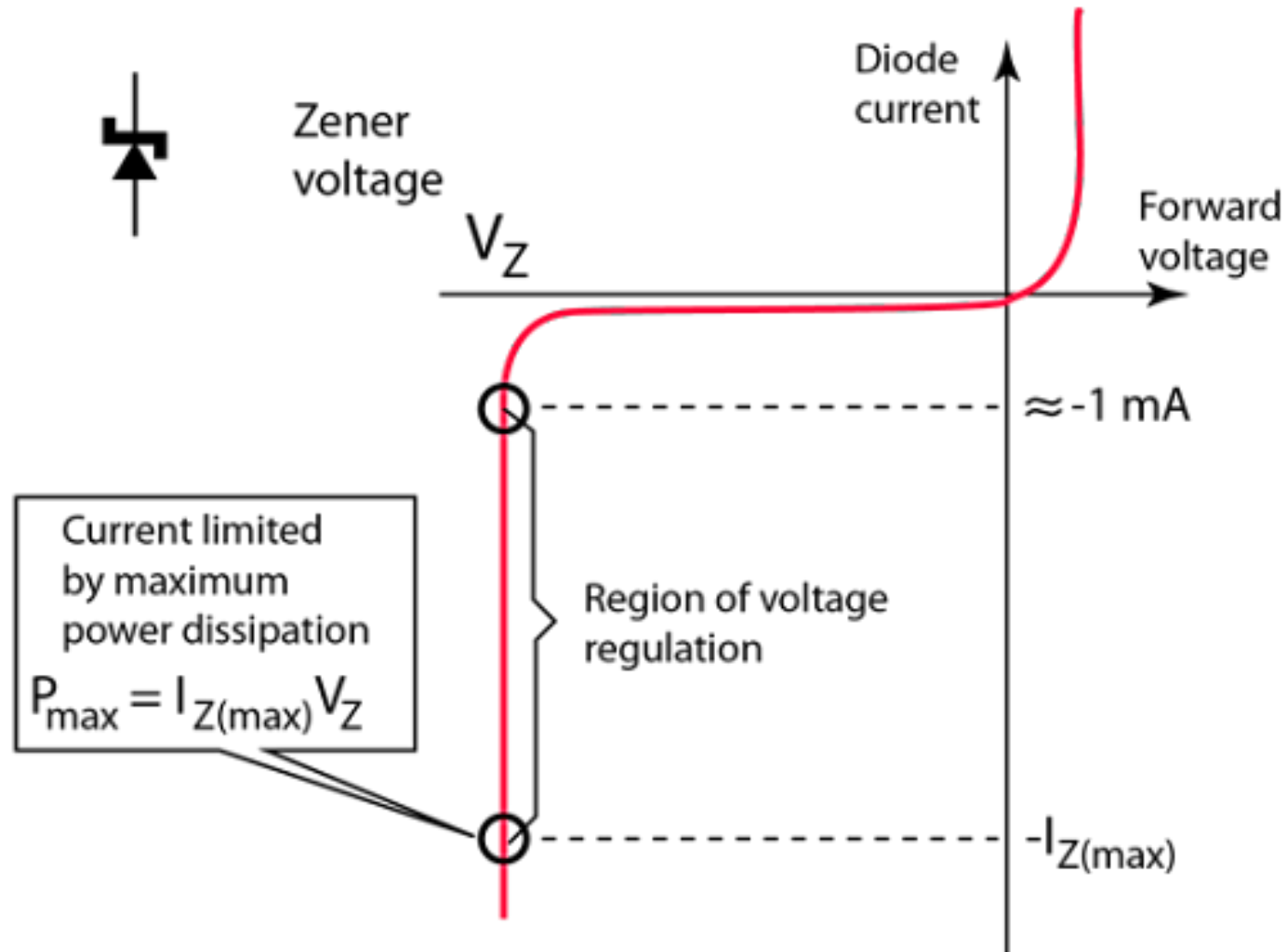
- As we said before the P-N junction diode has a breakdown region when it reverse biased, In this case the current pass through diode is too high that burn the diode.



Avalanche Breakdown

- When diode is in a reverse-biased at certain voltage called V_z the depletion region is falls down and an energy acquires from the applied potential to the free carriers make this carriers collides with crystal ion and destroy the covalent bonds and makes new electron-hole pair generated and this new carriers also pick up sufficient energy from the applied voltage and collide with another crystal ion and also break the covalent bond and also release another free electron and free holeetc.
- This produce a huge no. of free carriers make a large current that burn the diode and makes it breakdown.
- This cumulative process of producing free carriers called “Avalanche multiplication” makes breakdown called “Avalanche breakdown”.

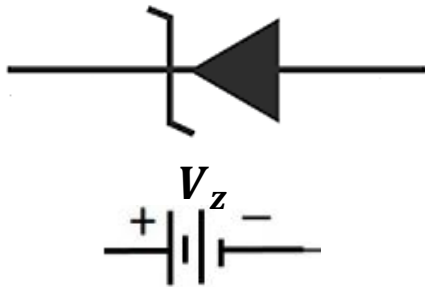
- Zener diode is a special type of diode designed to reliably allow current to flow "backwards" when a certain set reverse voltage, known as the *Zener voltage*, is reached.



Models of Zener diode

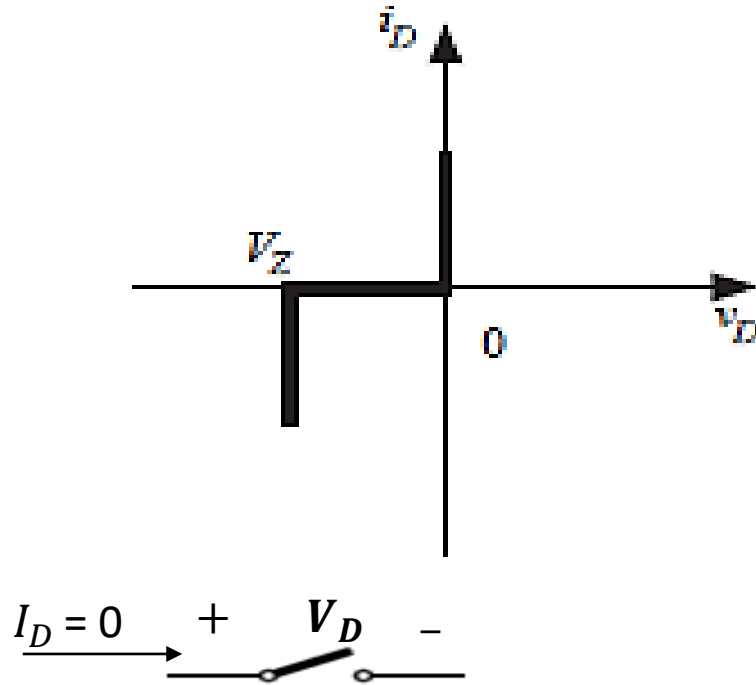
- Ideal Zener diode model
- Practical Zener diode model

Ideal Zener diode model



Regulator

$$V_D = -V_Z$$

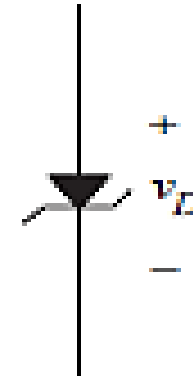


Reverse biased

$$V_D < 0, I_D = 0$$

Open Circuit

OFF



$$I_D > 0$$

Forward biased

$$V_D = 0, I_D > 0$$

Short Circuit

ON

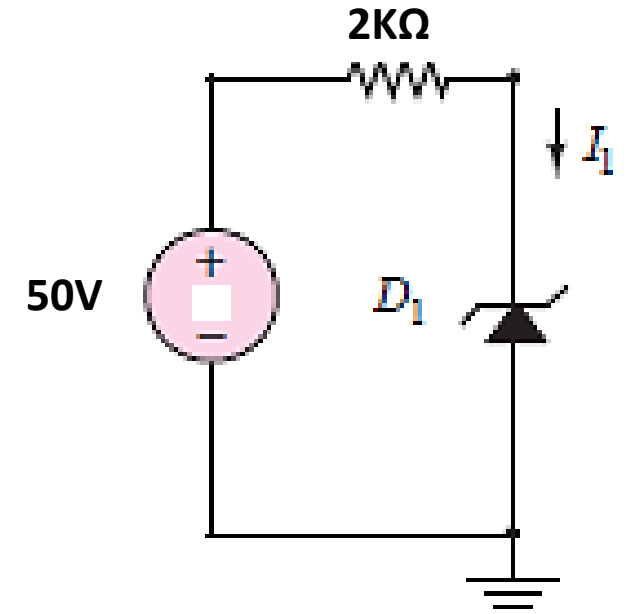
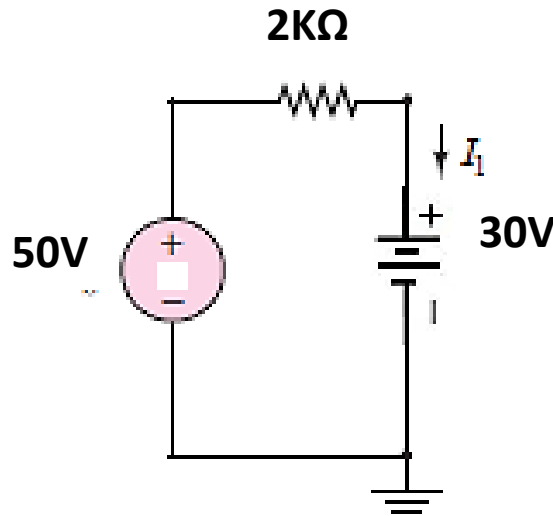
Example 1

Assume Zener diode Ideal $V_z = 30$, find I in Zener diode ?

Solution:

$50V > V_z = 30$ So, Zener is a regulator.

$$I = \frac{50-30}{2k} = 10 \text{ mA}$$



Example 2

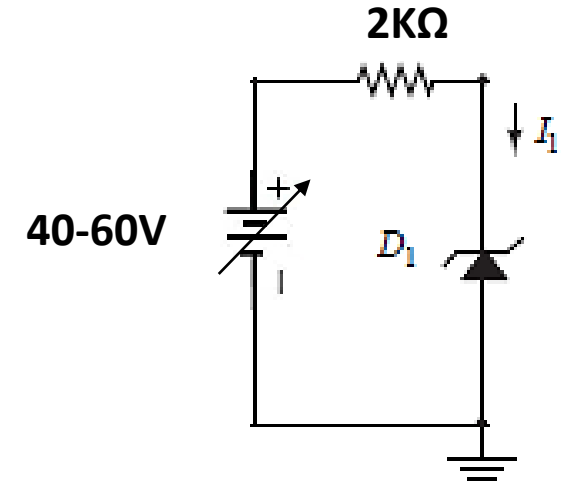
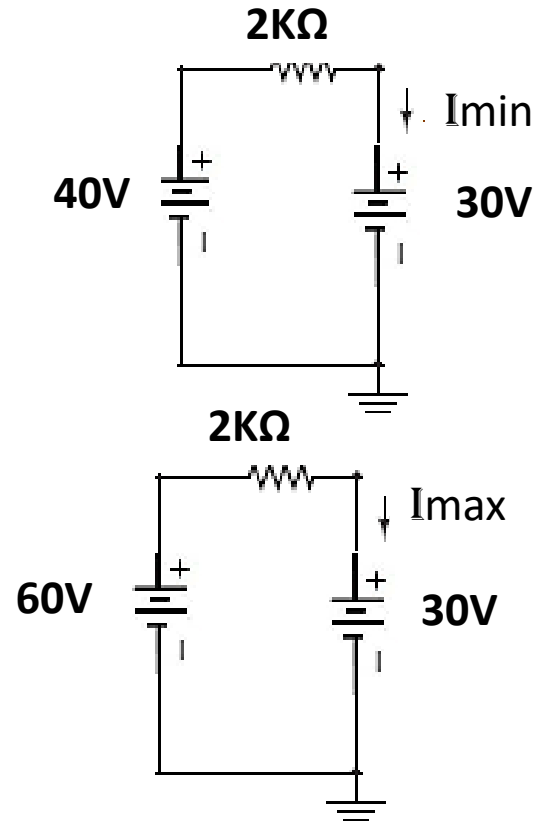
Assume Zener diode Ideal $V_z = 30V$, $V_s = 40-60V$. Find I_{max} & I_{min} in Zener diode

Solution:

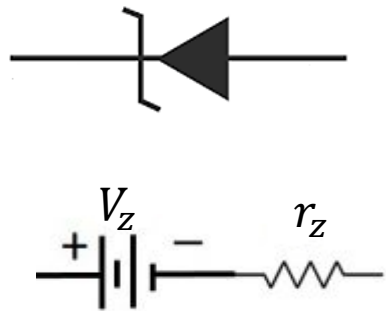
$40-60 V > V_z = 30$ So, Zener is a regulator.

$$I_{min} = \frac{40-30}{2k} = 5 \text{ mA}$$

$$I_{max} = \frac{60-30}{2k} = 15 \text{ mA}$$



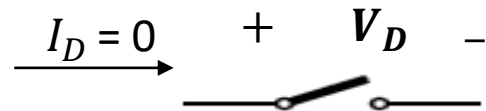
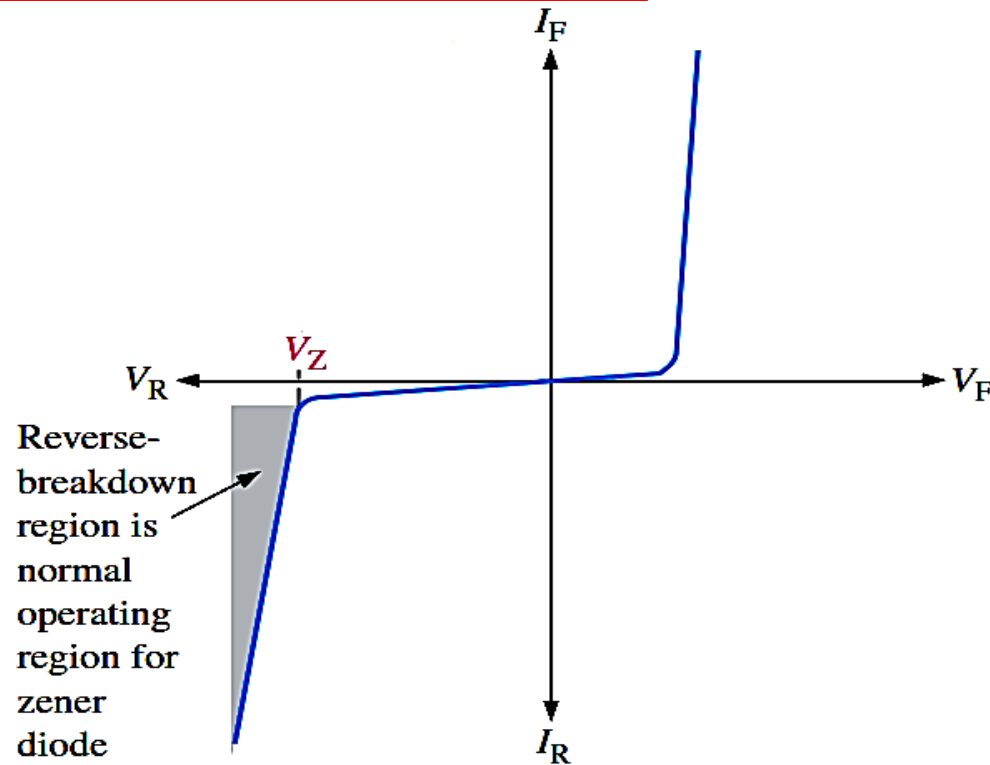
Practical Zener diode model



Regulator

$V_Z = \text{DC value}$

$r_z = 5 \rightarrow 50\Omega$

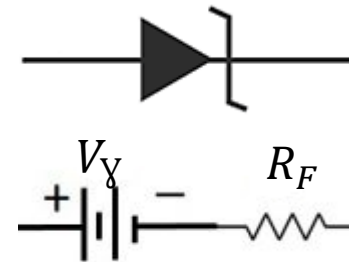


Reverse biased

$V_D < 0, I_D = 0$

Open Circuit

OFF



Forward biased

$V_Y = 0.7\text{v Si}$

$R_F = 5 \rightarrow 50\Omega$

ON

Example 3

For the following circuit $V_z = 30\text{V}$, $r_z = 20\Omega$, $V_s > V_z$, $I_{\max} = 2\text{mA}$ & $I_{\min} = 1\text{mA}$ in Zener diode. Find V_o .

Solution:

At $I_{\min} = 1\text{mA}$

$$V_o = 30 + 1\text{mA}(20) = 30.02\text{V}$$

At $I_{\max} = 2\text{mA}$

$$V_o = 30 + 2\text{mA}(20) = 30.04\text{V}$$

