ZENER DIODES

Analog Electronics

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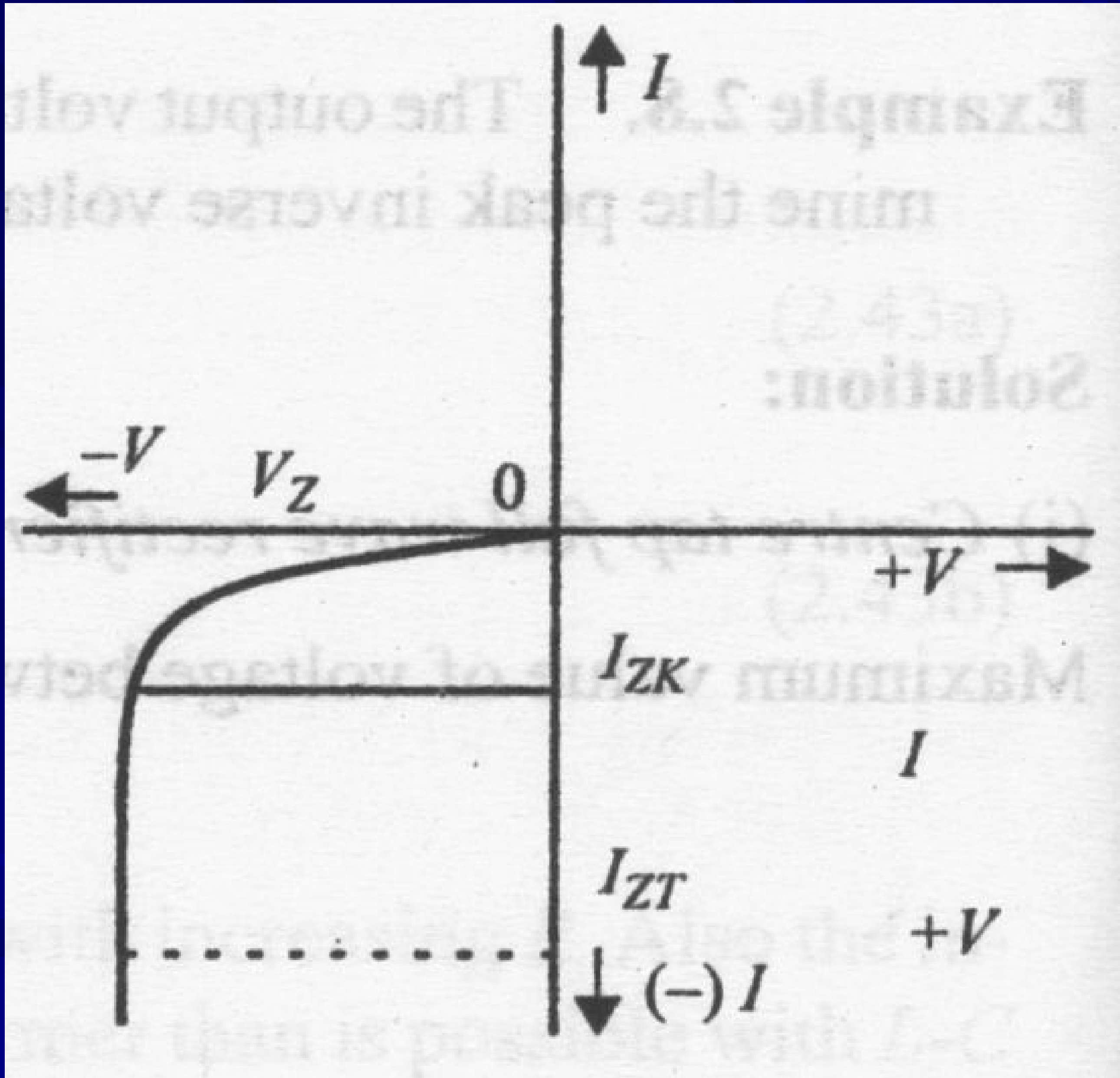
In the breakdown region, large change in diode current produce only small changes in diode voltage.

So a semiconductor P-N junction diode designed to operate in the breakdown, region may be employed as a constant voltage device.

The diode used in such a manner are called Zener diodes. It is used in the reverse-biased condition.

These diodes are used as a voltage regulator.


I
−V
V_Z
0
+V
I_{ZK}
I
I_{ZT}
+V
(−) I

Zener Diode Specifications

Zener Voltage

The manufacturers specify the value of breakdown voltage known as zener voltage, $\mathbf{V_z}$.

Value of $\mathbf{V_z}$ are available at various valus from 2.4 to 200 V with accuracies between 5 and 10 %, depending upon cost.

Power Dissipation

Power dissipation in the diode is the product of Vz and reverse current Iz. The maximum power ratings ranging from 150 mW to 50 W

Breakover Current

It is a current (I_{ZK}) which flows at low values of I_z.

It may be specified some value of current, in the neighborhood of the breakover knee, where the voltage across the diode starts to differ greatly from V_z.

Dynamic Impedance

Zener dynamic impedance is defined as Z_z:

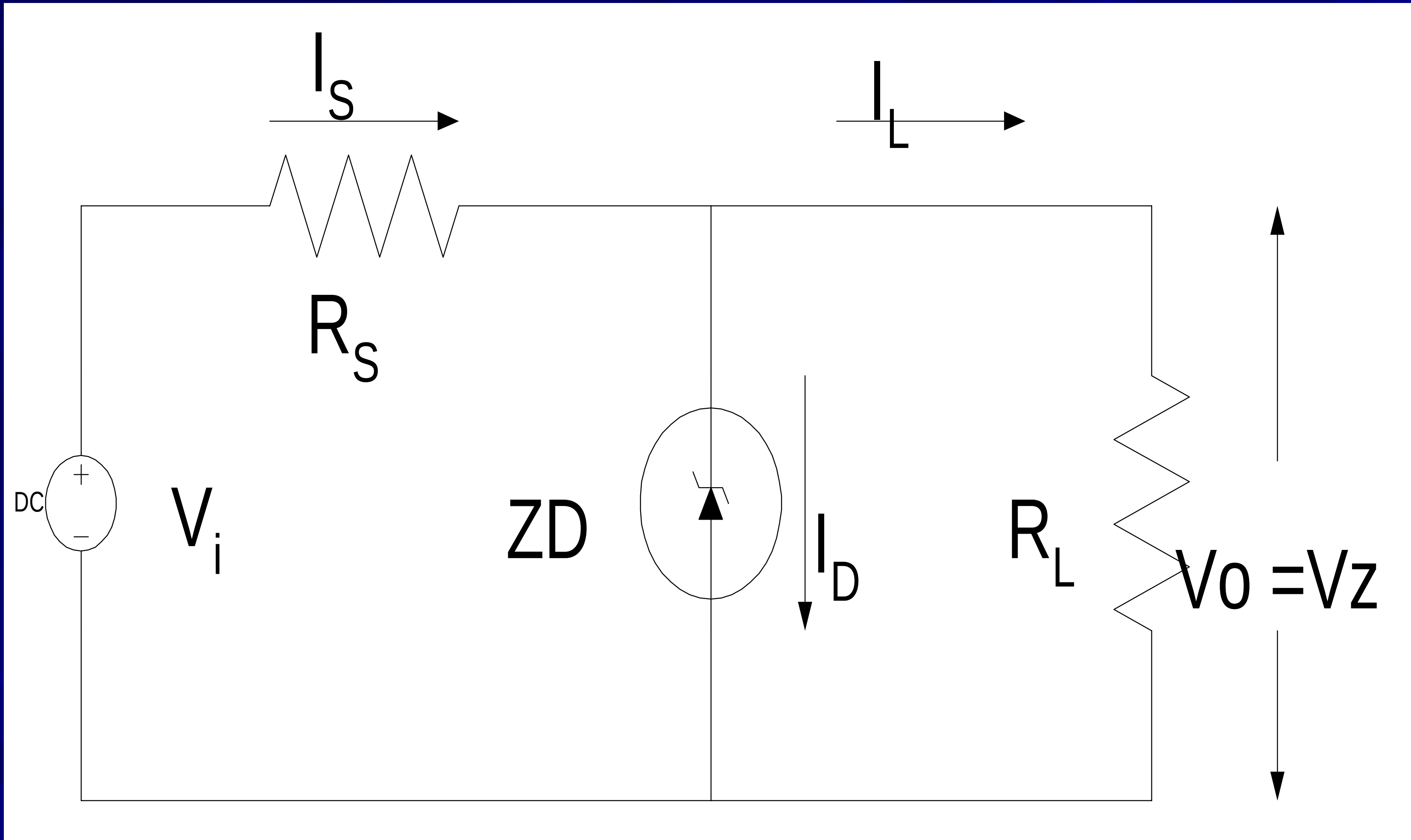
$$z_z = \frac{\Delta V_z}{\Delta I_z}$$

Ideally, Z_z is zero for a perfectly vertical breakdown curve, but in practice may vary from several ohms to several hundreds ohms, depending upon the particular Zener diode voltage and the operating current.

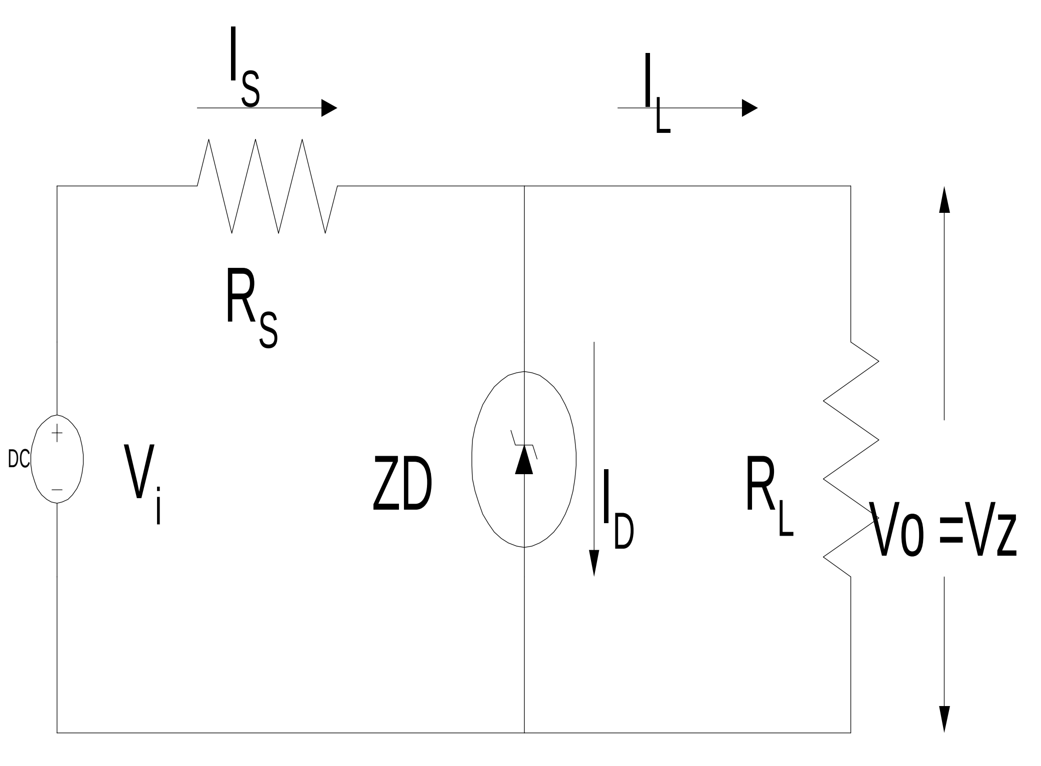
So, the equation is more useful in the form:

$$\Delta V_Z = Z_Z \Delta I_Z$$

THE VOLTAGE REGULATOR CIRCUIT



Under Input Voltage Constant Condition



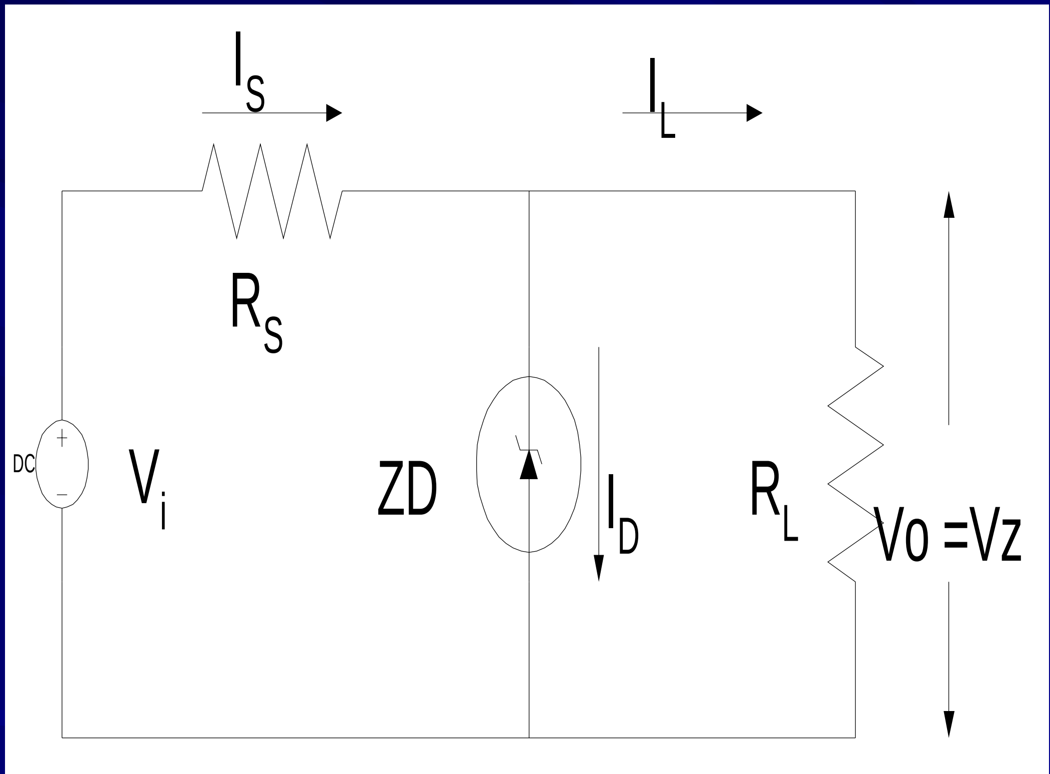
$$R_{L\min} = \frac{R_S V_z}{V_i - V_z}$$

$$R_{Lmak} = \frac{V_Z}{I_{L\min}}$$

$$I_{L\min} = I_{RS} - I_{ZM}$$

$$I_{Lmak} = \frac{V_L}{R_{L\min}}$$

Under Input Voltage Variation Condition



$$V_{i\min} = \frac{(R_L + R_S)V_Z}{R_L}$$

$$I_{Rmak} = I_{ZM} + I_L$$

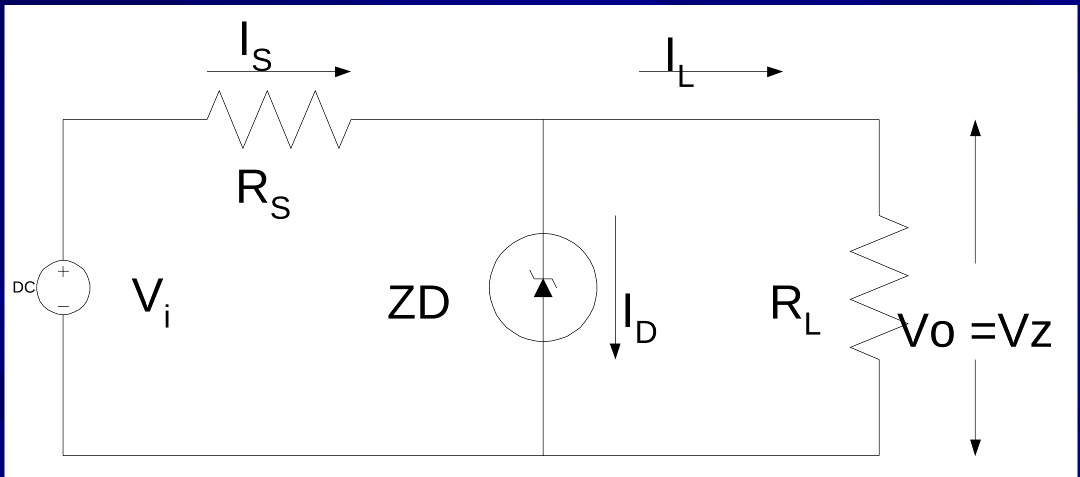
$$V_{imak} = I_{Rmak} R_S + V_Z$$

Exercise 1

Using the following figure, if Rs = 1 kΩ, Vz = 10 volt, I_{zm} = 32 mA and V_i = 50 volt, determine:

a. Ratings ranging of R_L and I_L

b. Ratings ranging of Power Dissipation



Exercise 2

Using the following figure, if Rs = 220 Ω, Vz = 20 volt, I_{zm} = 60 mA and R_L = 1,2 kΩ determine ratings ranging of V_i