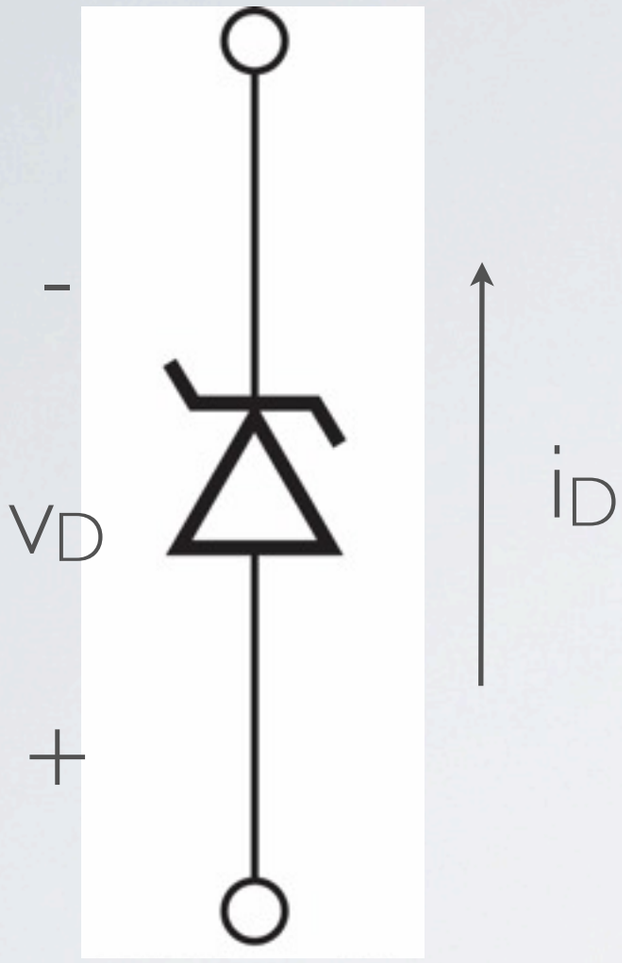
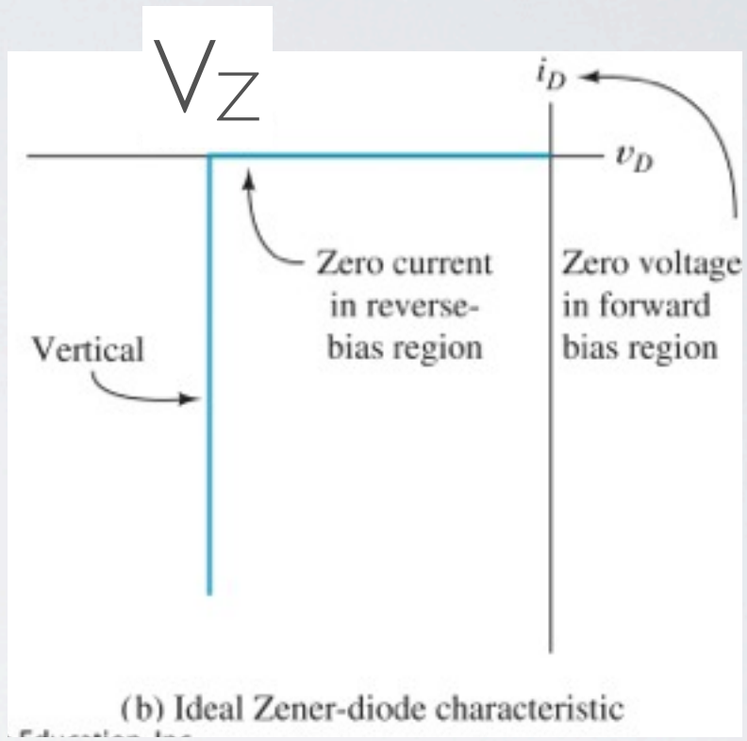
ZENER REGULATOR

INEL 4076 Fall 2013



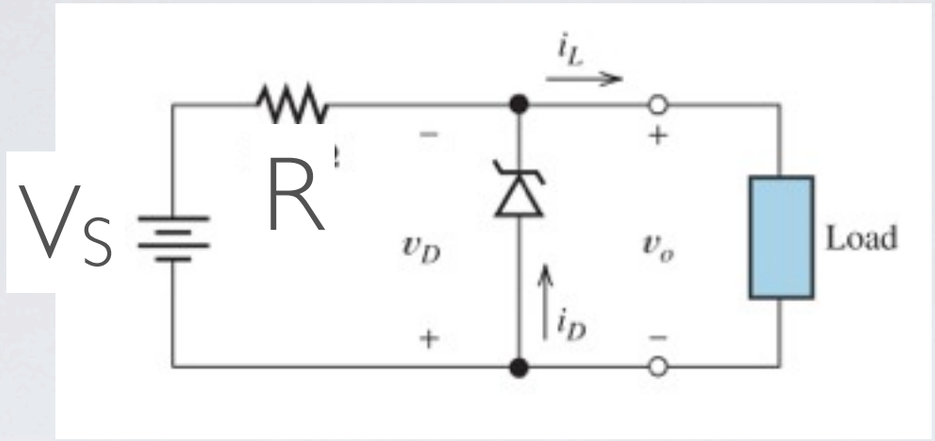


(b) Ideal Zener-diode characteristic

Zener diodes

- reverse-bias operation
- keeps an approx. constant voltage independent of diode's current

Voltage regulator



Let:

- V_Z : Zener diode's nominal voltage.
- $i_{Z,min}$: minimum current through diode required for proper operation.
- $i_{L,max}$, $i_{L,min}$: maximum and minimum load's current.
- $V_{S,max}$, $V_{S,max}$: maximum and minimum source voltage levels

For proper operation, select R so that

$$R \leq \frac{V_{S,min} - V_Z}{i_{Z,min} + i_{L,max}}$$

Maximum power dissipated in the resistor:

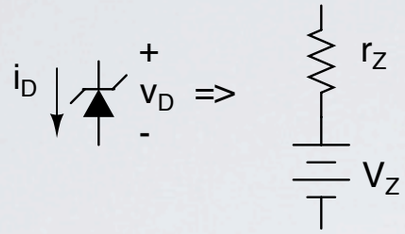
$$P_{R,max} = \frac{(V_{S,max} - V_Z)^2}{R}$$

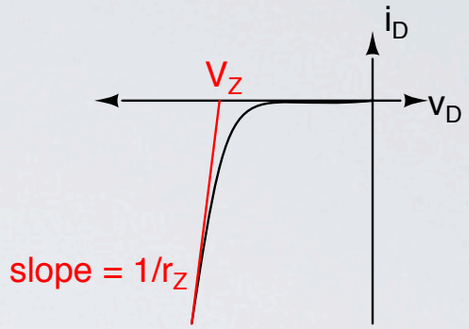
Maximum power dissipated in the diode:

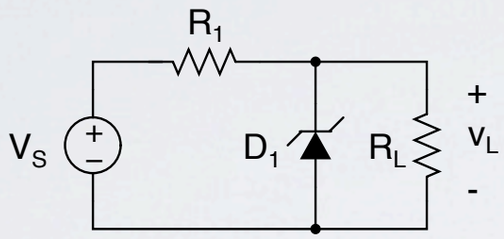
$$P_{D,max} = V_Z \times \left(\frac{V_{S,max} - V_Z}{R} - i_{L,min} \right)$$

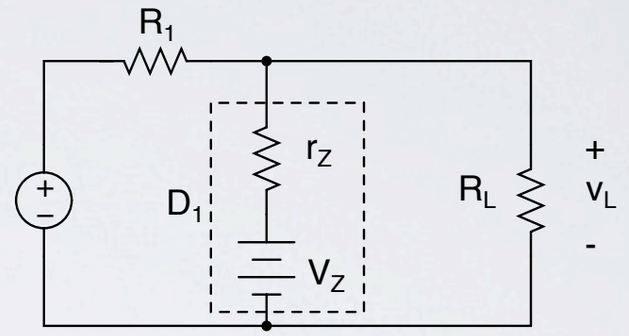
D and R must have a power rating greater than $P_{D,max}$ and $P_{R,max}$, respectively.

Piece-wise linear approx.









Analysis of Zener diode circuit using piecewise linear approximation:

1. Transform voltage source to current source then back to voltage source:

$$V_S' = \frac{V_S}{R_1}(R_1||R_L) = \frac{V_S}{R_1}\frac{R_1 \times R_L}{R_1 + R_L} = \frac{R_L}{R_1 + R_L}V_S$$

   in series with a resistance $R_1' = R_1||R_L$.

2. Find diode's current:

$$i_D = \frac{V_S' - V_Z}{R_1||R_L + r_Z}$$

3. calculate V_L by finding voltage across diode:

$$V_L = V_Z + r_Z \times i_D$$