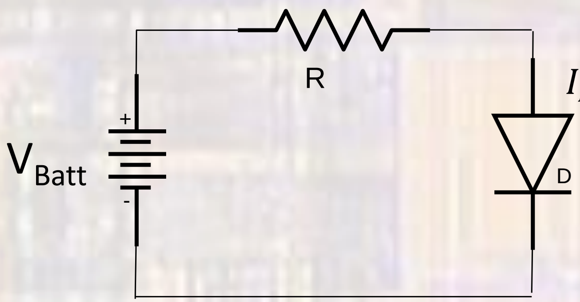
Diode Circuit Analysis

Last updated 1/25/22

Diode Circuit Analysis

- "Exact" Solution
  - Transcendental Equation
    - You have the tools to solve this



$$I_D = I_S\left(e^{\frac{V_D}{nV_T}} - 1\right)$$

$$V_{Batt} = I_D R + V_D$$

$$V_{Batt} = I_S\left(e^{\frac{V_D}{nV_T}} - 1\right)R + V_D$$

I_S = 5.3e-15, n = 1, V_{batt} = 3.3V, R = 1KΩ
V_D = 0.6999V, I_D = 2.601mA

Diode Circuit Analysis

- Ideal Solution
  - $V_D = V_{Th} = 0V$

$$V_{Batt} = I_D R + V_D$$

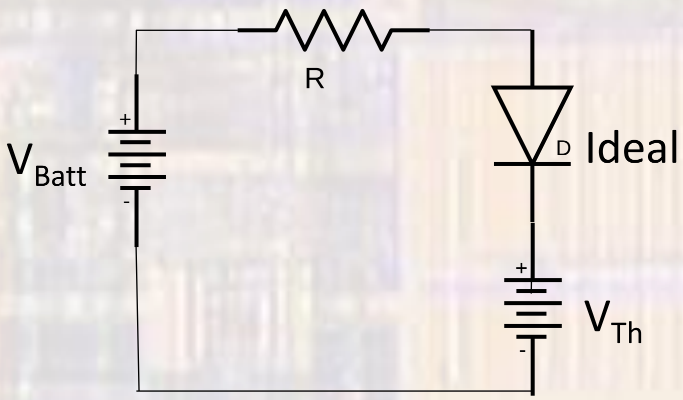
$$V_{Batt} = I_D R$$

$$I_D = V_{Batt}/R$$

V_{batt} = 3.3V, R = 1KΩ, ~~V_{TH} = 0.7V~~, ~~R_F = 5Ω~~
I_D = 3.3mA

Diode Circuit Analysis

- Ideal Solution (with V_{Th})
  - $V_D = V_{Th} = 0.7V$



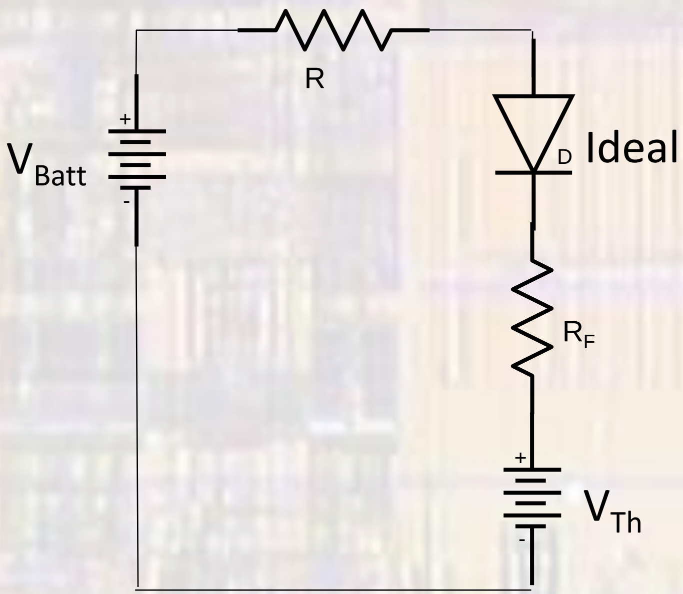
$$V_{Batt} = I_D R + V_{Th}$$

$$I_D = (V_{Batt} - V_{Th})/R$$

$V_{batt} = 3.3V$, $R = 1K\Omega$, $V_{TH} = 0.7V$, ~~$R_F = 5\Omega$~~
$I_D = 2.60mA$

Diode Circuit Analysis

- Piecewise Linear Solution
  - $V_{Th} = V_{\gamma} = 0.7V$
  - $R_F = 5\Omega$



$$V_{Batt} = I_D R + I_D R_F + V_{Th}$$

$$I_D = (V_{Batt} - V_{Th})/(R + R_F)$$

$V_{batt} = 3.3V$, $R = 1K\Omega$, $V_{TH} = 0.7V$, $R_F = 5\Omega$
$I_D = 2.587mA$

Diode Circuit Analysis

- Comparison

Exact

Simulate instead

$$V_{Batt} = I_S\left(e^{\frac{V_D}{nV_T}} - 1\right)R + V_D$$

I_S = 5.3e-15, n = 1, V_{batt} = 3.3V, R = 1KΩ
V_D = 0.6999V, I_D = 2.601mA

Ideal

Only acceptable for determining functionality

$$V_{Batt} = I_D R$$

V_{batt} = 3.3V, R = 1KΩ, ~~V_{TH} = 0.7V~~, ~~R_F = 5Ω~~
I_D = 3.3mA

Ideal w/V_{Th}

The best choice for almost all situations

$$V_{Batt} = I_D R + V_{Th}$$

V_{batt} = 3.3V, R = 1KΩ, V_{TH} = 0.7V, ~~R_F = 5Ω~~
I_D = 2.60mA

Piecewise linear

$$V_{Batt} = I_D R + I_D R_F + V_{Th}$$

V_{batt} = 3.3V, R = 1KΩ, V_{TH} = 0.7V, R_F = 5Ω
I_D = 2.587mA