3.16

**Given:** A battery and its I-V characteristic, 40Ω resistor

**Find:**

- Voltage and current through resistor using graph methods
- Replace battery w/ Thevenin from 3.15 and repeat

(a) The I-V graph of the resistor is: \( I = \frac{V}{40Ω} \)

- Superimpose this line on the given graph; the intersection is the answer

(b) From the graph, we see:

- \( V_{oc} \approx 4.5V \)
- \( I_{sc} \approx -0.12A \)
- The Thevenin equivalent battery will be linear (by definition)

\[
\begin{align*}
V & \approx 3.3 \\
I & \approx -0.8
\end{align*}
\]
3.17 \textbf{Given:} \quad 40 \Omega \text{ resistor, } \ V_0 = 6 \text{ V, } \ I_{40} = -0.1125 \text{ A}

\textbf{Find:} \quad V_T, \ R_T

\text{THE I-V GRAPH OF THE BATTERY CAN BE FOUND SINCE WE ASSUME THE RESISTOR IS LINEAR (}I = V/R_0\text{) AND WE KNOW } V_0 \text{ AND A POINT WHERE THE Z GRAPHS INTERSECT.}

\begin{align*}
V' &= 0.1125A(40 \Omega) = 4.5 \text{ V} \\
I_{sc} &= -0.45 \text{ A} \\
R_T &= -\frac{6}{-0.45} = 13.3 \Omega
\end{align*}

\[ V_T = 6 \text{ V, } R_T = 13.3 \Omega \]
3.20 Find: $V_{oc}$, $I_{sc}$

- $I_{sc}$ is found by shorting the terminals and using KCL at node A.

- Notice that when there is no voltage drop across $N_1$, that 1mA flows through it.
  
  KCL at node A
  
  \[ I_{sc} = 4 - 1mA \]
  
  $I_{sc} = 3mA$

- $V_{oc}$ is found by plotting the Thévenin equivalent circuit (remove $N_1$) on top of the I-V graph of $N_1$. The intersection is the operating point.

  $V_T = V_{oc} = 3V$

  $I_T = I_{sc} = \frac{3V}{750\Omega} = 4mA$

  $V_{oc} = V_{N_1} \approx 1.7V$
3.207 FIND: THE POWER ENTERING $N_1$

$I_0 = 60\text{mA}$
$R_1 = 800\Omega$
$R_2 = 400\Omega$

1. OPEN THE CIRCUIT AT AB AND FIND THEVENIN
2. Plot load line against $I-V$ graph of $N_1$ to find $V, I$
3. $P = VI$

$V_{oc} = I_0 R_1 = 4.8\text{V}$
$I_{sc} = \frac{I_0 R_1}{R_1 + R_2} = +0.004 = +4\text{mA}$

If the graph was more properly drawn,
$I \approx 2.1\text{mA}$
$V \approx 2.4\text{V}$
3.32 Find: Average power across 50Ω resistor for given signal

\[ V(t) = \frac{3V}{0.0025}(t) \quad 0 \leq t \leq 0.002 \]

\[ P_{AV} = \frac{1}{T} \int_0^T V(t)I(t)dt = \frac{1}{0.002} \int_0^{0.002} \frac{V^2}{R}dt = \frac{1}{0.002} \frac{1}{2} \frac{(3V)^2}{50\Omega} \times \frac{1}{3} \times \frac{1}{50} \times (0.002)^3 \]

\[ P_{AV} = 0.60\text{mW} \]

3.33 Find: Power dissipated in OP AMP

\[ P = I_1V_1 + I_2V_2 + I_3V_3 \]

\[ = (60\text{mA})(15V) + (-10\text{mA})(-15V) + (-50\text{mA})(2V) \]

\[ P = 950\text{mW} \]
13.7 Given the circuit below, find \( i_0 \) by using a Thévenin equivalent and the I-V characteristics of the diode (fig 13.5).

1. Remove the diode and find \( V_{oc}, I_{sc} \)

   \[ V_{oc} = \left( \frac{R_1}{R_1 + R_2} \right) V_0 \]  
   (Voltage divider)

   \[ V_{oc} = \frac{1000}{2500} (5) = 2 \text{V} \]

   - When the AA' terminals are shorted, no current will flow through \( R_1 \).
     
     \[ I_{sc} = \frac{V_0}{R_2} = 3.3 \text{mA} \]

2. Now compare the I-V graph of the Thévenin with that of the diode. Where they intersect is the operating point.

\[ i_D \approx 2.2 \text{mA} \]
13.9 Find: \( i \)
- Assume that the voltage drop across a forward biased diode is 0.7V

\[ 2.5V - i(500\Omega) - 0.7 - 0.7 = 0 \]
\[ i = \frac{1.1V}{500\Omega} = 2.2mA \]

13.10 Find \( i \) using the assumption that the voltage drop across a forward biased diode is 0.7V

1. Use KCL to find \( V_A \)

\[ \frac{4V - V_A}{100} - \frac{V_A - 0.7}{100} - \frac{V_A - (0.7 + 0.7)}{100} = 0 \]
\[ V_A = \frac{6.1}{3} = 2.033 \]
\[ i = \frac{V_A - (0.7 + 0.7)}{100} = \frac{2.033 - 1.4}{100} = 6.33mA \]