Ch. 20
P 7, 30, 31, 32, 61

7. 

\[ R_1 = 1.00 \, \Omega \]

\[ I_{in} = I_{out} \]

\[ I = I_2 + I_3 \]

\[ R_3 = 13.0 \, \Omega \]

a. If \( I = 2.35 \, A \) \( \implies I_2 = 1.61 \, A \) (ex. 20.3)

Since \( I = I_2 + I_3 \)

Then \( I_3 = I - I_2 = 2.35 \, A - 1.61 \, A = 0.74 \, A \)

b. In ex. 20.3, \( V_p = \frac{9.65 \, V}{1} \rightarrow \) This is the "voltage drop" across \( R_2 \); but the same drop should be across \( R_3 \) since \( R_2 \) and \( R_3 \) are in parallel.

So...

\[ V_p = I_3 R_3 \]

\[ I_3 = \frac{V_p}{R_3} = \frac{9.65 \, V}{13.0 \, \Omega} \]

\[ I_3 = 0.742 \, A \]

*Note: You should work through ex. 20.3, so that you can practice this problem from beginning to end. This would be good practice for quizzes, exams, etc.*
Note: The diagram shows you "pre-guessed" currents. Those are what we'll use, keeping in mind that any unique branch has the same current throughout, until it comes to a junction.

One loop, clockwise around the outside:

1. \(-I_1R_1 + E_1 - I_1R_5 - I_2R_2 - E_4 - I_3R_3 + E_3 - I_3R_3 = 0\)

   Why a "-" sign?

   Lower loop, clockwise:

2. \(E_2 - I_2R_2 - I_2R_2 - I_3R_4 - E_4 - I_3R_3 + E_3 - I_3R_3 = 0\)

   A 3rd equation is gotten from analyzing a junction. Current in = Current out. At point "a" (between \(R_3\) & \(R_4\)):

3. \(I_3 = I_1 + I_2\)

Now we have 3 equations (1, 2, & 3) and three unknowns \((I_1, I_2, I_3)\).

The physics is done—now it's all algebra!
1. \( E_1 - E_4 + E_3 - I_1 (R_1 + r_1 + R_5) - I_3 (r_4 + r_3 + R_3) = 0 \)
   
   \[
   I_1 = - \frac{I_3 (r_4 + r_3 + R_3) + E_1 - E_4 + E_3}{R_1 + r_1 + R_5}
   \]

2. \( E_2 - E_4 + E_3 - I_2 (r_2 + R_2) - I_3 (r_4 + r_3 + R_3) = 0 \)
   
   \[
   I_2 = - \frac{I_3 (r_4 + r_3 + R_3) + E_2 - E_4 + E_3}{(r_2 + R_2)}
   \]

3. \( I_3 = I_1 + I_2 \)

   \[
   I_3 = - \frac{I_3 (r_4 + r_3 + R_3) + E_1 - E_4 + E_3}{R_1 + r_1 + R_5} + \frac{I_3 (r_4 + r_3 + R_3) + E_2 - E_4 + E_3}{(r_2 + R_2)}
   \]

   \[
   I_3 = \frac{[2 + 0.05 + 78] \Omega}{[5 + 1 + 20] \Omega} + 24V \cdot 36V + 6V + \frac{[20 + 0.05 + 78] \Omega}{[5 + 1 + 20] \Omega} + 45V \cdot 36V + 6V
   \]

   \[
   I_3 = \frac{-78.25}{25.1} I_3 + \frac{-6V}{25.1 \Omega} - \frac{78.25}{40.5} I_3 + \frac{18V}{40.5 \Omega}
   \]

   \[
   0.05 I_3 = 0.205 \quad \rightarrow \quad I_3 = \frac{3.39 \times 10^{-2} A = 33.9 \text{ mA}}{}
   \]

   Substitute into (1):
   
   \[
   I_1 = -(3.39 \times 10^{-2} A) \left( \frac{78.25}{25.1} \right) + \frac{-6V}{25.1 \Omega}
   \]
   
   \[
   I_1 = -0.345 A
   \]

   \[
   \text{goes opposite direction if guess.}
   \]

So \( I_2 = I_3 - I_1 \)

\[
I_2 = 0.339 A - 0.345 A
\]

\[
I_2 = 0.379 A
\]
61. \( RC = 10 \ \text{ms} = 10 \times 10^{-3} \ \text{s} \)

a. \( C = 8 \ \mu \text{F} = 8 \times 10^{-6} \ \text{F} \)

\[
RC = R \left( 8 \times 10^{-6} \ \text{F} \right) = 10 \times 10^{-3} \ \text{s}
\]

\[
R = \frac{10 \times 10^{-3} \ \text{s}}{8 \times 10^{-6} \ \text{F}} = 1250 \ \Omega
\]

b. \( V_0 = 12 \ \text{kV} = 12,000 \ \text{V} \); \( V = 600 \ \text{V} \)

\[
V = V_0 e^{-t/RC}
\]

\[
\frac{V}{V_0} = e^{-t/RC}
\]

\[
\ln \left( \frac{V}{V_0} \right) = -t/RC \implies t = -RC \ln \left( \frac{V}{V_0} \right)
\]

\[
t = - \left( 10 \times 10^{-3} \ \text{s} \right) \ln \left( \frac{600}{12000} \right)
\]

\[
t = \left[ 3.00 \times 10^{-2} \ \text{s} = 30.0 \ \text{ms} \right]
\]