Problem 1

\[8i_x + 25i_x - 15i_x - 60 = 0\]
\[18i_x = 60\]
\[i_x = 3.33 \text{A}\]

Problem 2

By voltage division:

\[V_{th} = v_0 = 20 \times \frac{40}{10+40} V = 16 V\]

\[R_{th} = 10/40 \Omega = 8 \Omega\]

\[R_{th} = 80/20 = 16 \Omega\]

\[V_{th} = (80/20)(2 + \frac{3}{8})\]
\[= 16 \times \frac{19}{8} = 38 V\]
**Problem 3**

\[ V_{th} = v_2 - v_1 \]
\[ v_1 = 20 \times 2 = 40V \]

To find \( v_2 \), apply KVL to the bottom loop,

\[-12 + 10i + 10(2 + i) + 5i = 0 \]
\[ i = -0.32A \]
\[ v_2 = 5i = -0.32 \times 5 = -1.6V \]
\[ V_{TH} = v_2 - v_1 = -1.6 - 40 = -41.6V \]
\[ R_{TH} = 20 + 5/(10 + 10) \Omega = 24 \Omega \]

**Problem 4**

By KCL,
\[ I = \frac{V_x}{30} + 2V_x \]

KVL around left loop:
\[ 6\left(\frac{V_x}{30} + 2V_x\right) + V_x - 50 = 0 \]
\[ \Rightarrow V_x = 3.788V \]
\[ V_{TH} = VX = 3.788V \]

To find \( R_{th} \), turn off 50V with short circuit, supply 1A source, Need to find \( v_o \). Note \( v_o = V_x \)

KCL at top node:
\[ \frac{V_x}{30} + \frac{V_x}{6} + 2V_x = 1, V_x = 0.455V, \]
\[ \Rightarrow v_o = 0.455V \]
\[ \Rightarrow R_{th} = \frac{v_o}{I} = 0.455 \Omega \]
\[ I_v = V_{TH}/R_{TH} = 8.325A \]

\[ V_{TH} = 3.788V, R_{TH} = R_N = 0.455 \Omega, I_n = 8.325A \]
Problem 5

\[ I_y = 4 - ix \]

KVL along right mesh:
\[ 5i_x + 4(4 - ix) - 8ix = 0 \]
\[ i_x = 2.286A \]
\[ I_y = 4 - ix = 1.714A \]

To find \( R_N \), turn off 4A, supply 1A source, need to find \( v_0 \)

Since \( i_x \) = 1A, by KVL
\[ v_0 = 4i_x - 5i_x + 8i_x = 7i_x = 7V \]
Then,
\[ R_N = \frac{v_0}{1} = 7\Omega \]

\[ I_{in} = 1.714A, R_N = 7\Omega \]

Problem 6

\[ 6i_1 + 3(i_1-i_2) - 90 = 0 \]
\[ 4i_2 + 2i_3 - 3(i_1-i_2) = 0 \]
\[ i_3 - i_2 = 3 \]
\[ i_1 = 11A \]
\[ i_2 = 3A \]
\[ i_3 = 6A \]
\[ V_{ab} = v_1 = 4i_2 = 12V \]
\[ V_{cd} = v_2 = 2i_3 = 12V \]

(a) a-b
\[ R_N = \frac{4}{(6/3 +2)}\Omega = 2\Omega \]
\[ I_N = \frac{V_{ab}}{2} = 6A \]

(b) c-d
\[ R_N = \frac{2}{(6/3 +4)}\Omega = 1.5\Omega \]
\[ I_N = \frac{V_{cd}}{1.5} = 8A \]

You may also use source transformation to obtain the same results
Problem 7

Since same current goes through the left 3Ω, and 6Ω, voltage division can be applied to find $v_0$.

$v_0=18\times \frac{6}{6+6}V = 12V$
\[v_1=3 \times 0.25v_0 = 9V\]
$V_{TH}=v_0-v_1=3V$

To find $R_{TH}$, turn off 18V, supply 1A source, need to find $v_s$.
In this case 3Ω and 6Ω are in parallel.

$v_0 = (3/6) \times 1 = 2V$
$v_1 = 3i_3 = 3 \times (0.25v_0 - 1) = -1.5V$
$v_s = v_0-v_1 = 3.5V$
$R_{TH} = v_s/1 = 3.5Ω$

$V_{TH}=3V, R_{TH}=3.5Ω$

Problem 8

By KCL, $I_N = i_1 - i_2$
$i_1, i_2$ can be found by current division:

$I_N = i_1-i_2=8 \times \frac{20}{30+20} - 8 \times \frac{40}{30+40} A = -1.371A$
$R_S = R_{TH} = (30+20)/(30+40)Ω = 9.167Ω$
$V_{TH} = I_N R_{TH} = -40V$
Problem 9

Need to compute Thevenin's equivalent with respect to the two terminals:

\(-30+6i+4i-10+10(i-3)=0\)
\(i=3.5A\)

\(V_{TH}=4i-10=4V\)
\(R_{TH}=\frac{4}{(6+10)}=3.2\Omega\)

\(P_{max}=(V_{TH})^2/(4R_{TH})=1.25W\)

Problem 10

\(V_{TH}=v_0=10 \times \frac{20}{20+5} = 8V\)

\(v_s=6V\)
\(v_x=4V\)
\(R_{TH}=v_x/1=26\Omega\)

\(P_{max}=(V_{TH})^2/(4R_{TH})=0.615W\)
Problem 11

\[ V_{TH} = V_{20\Omega} - V_{5\Omega} \]
\[ = 50 \times \frac{20}{30} - 50 \times \frac{5}{30} \]
\[ = 25V \]

\[ R_{TH} = \frac{10}{20} + \frac{25}{5} = 10.833\Omega \]

\[ P_{max} = \frac{(V_{TH})^2}{(4R_{TH})} = 14.424W \]