(1) Find the output voltage, $V_o$, for the opamp circuit shown in Figure 1.

$$V_x = \frac{5 \times 2k}{3k + 2k} = 2V \quad \text{At } A, \quad V_A = V_X = 2V$$

$$A \uparrow \downarrow A:$$

$$\frac{2-3}{10k} + \frac{2-1}{6k} + \frac{2-V_o}{20k} = 0$$

$$-2 + 4 + V_O = 0$$

$$V_o = 4V$$
(2) You are given the circuit shown in Figure 2.
(a) Find the Thevenin equivalent circuit, with respect to terminals a-b. Hint: If mesh doesn’t work try nodal.
(b) Draw the Thevenin equivalent circuit: include $V_{TH}$ and $R_{TH}$.
(c) What resistor placed between terminals a-b will give maximum power Transfer to this resistor? Determine the value of this power.

![Circuit Diagram](image)

Figure 2: Circuit for problem 2.

(a) \[ \frac{V_x - 72}{5} + \frac{V_x}{2a} + \frac{V_x - V_{ab}}{8} = 0 \]

\[ 8V_x - 576 + 2V_x + 5V_x - 5V_{ab} = 0 \]

\[ 15V_x - 5V_{ab} = 576 \]

(b) \[ \frac{V_{ab} - V_x}{8} + \frac{V_{ab} - 72}{12} = 0 \]

\[ 12V_{ab} - 12V_x + 8V_{ab} - 576 = 0 \]

\[ -12V_x + 20V_{ab} = 576 \]

\[ \begin{bmatrix} 15 & -5 \\ -12 & 20 \end{bmatrix} \begin{bmatrix} V_x \\ V_{ab} \end{bmatrix} = \begin{bmatrix} 576 \\ 576 \end{bmatrix} \]

\[ V_x = 60V \quad V_{ab} = V_{TH} = 64.8V \quad \text{Thevenin Voltage} \]
(2) cont. for \( R_{TH} 

\[ 8 \Omega \]
\[ 5 \Omega \]
\[ 3 \Omega \]
\[ 20 \Omega \]
\[ 12 \Omega \]
\[ \text{R}_{TH} \]

\[ 5 \times 20 = 4 \times 5 \]

\[ \text{Thevenin Resistance} \]

\[ \text{Thevenin Circuit} \]

\[ 64.2 \text{V} \]

\[ 698 \text{V} \]

\[ \text{For maximum power transfer.} \]

\[ P_o = \frac{V_p^2}{R_o} \]

\[ V_p = 32.4 \text{V} \]

\[ P_o = \frac{(32.4)^2}{6} \]

\[ P_o = 175 \text{ W} \]

Output power
(3) You are given the circuit of Figure 3.
   (a) Find the Norton equivalent circuit with respect to terminals a-b. You are required to find \( I_{NORTON} \) by actually finding the short circuit current.
   (b) Draw your Norton equivalent circuit showing the \( I_{NORTON} \), \( R_{TH} \) and terminals a-b.

![Circuit Diagram]

Figure 3: Circuit for problem 3.

(a) The circuit is the same as follows:

![Diagram with text]

From (b):
\[ I_{SS} = -1 \text{ mA} \]
\[ I_{NORTON} = -1 \text{ mA} \]

\[ R_{TH} = \frac{(5 \text{ k}\Omega)(15 \text{ k}\Omega)}{5 \text{ k}\Omega + 15 \text{ k}\Omega} = 3.75 \text{ k}\Omega \]

(b) Norton Circuit
(4) You are given the circuit of Figure 4.
(a) Give the value of the Thevenin voltage seen looking into terminals a-b.
(b) Determine the resistance $R_{TH}$ seen looking into terminals a-b.
(c) Draw your Thevenin equivalent circuit.

![Circuit Diagram]

Figure 4: Circuit for problem 4.

(a) Since there are no independent sources,\[V_{TH} = 0,\] (it is a dead circuit).

(b) Apply a source voltage of 1V at terminals a-b. Determine $I_S$ as shown. \[R_{TH} = \frac{V_2}{I_S} = \frac{1}{I_S}\]

Writing mesh equations.

**Mesh $I_X$**

\[-2V_x + 5(I_x - I_S) + 10I_x = 0\] (1) but $V_x = 2I_x$ (2) Substitute (2) into (1), clear

\[11I_x - 5I_S = 0\] (3)

**Mesh $I_S$**

\[-1 + 20I_S - 5(I_x - I_S) + 2V_x = 0\] (4) Substitute (4) into (2), clear

\[-I_x + 2.5I_S = 1\] (6)
(4) continued

From (13) and (5)

\[
\begin{bmatrix}
11 & -5.7 \\
-1 & 2.5
\end{bmatrix}
\begin{bmatrix}
I_x \\
I_y
\end{bmatrix} =
\begin{bmatrix}
0 \\
1
\end{bmatrix}
\]

\[I_s = 0.04074\]

\[R_{TH} = \frac{V_2}{I_s} = \frac{1}{0.0407} = 24.5\Omega\]

\[R_{TH} = 24.5\Omega\]

(6)

\[\text{Thevenin Circuit}\]
(5) Find the voltage across each capacitor in the circuit shown in Figure 5.

Figure 5: Circuit for problem 5.

To the right of a-b: \( C_{ab} = \frac{20 \times 60}{20 + 80} = 16 \ \mu F \)

To the right of c-d: \( C_{cd} = (14 + 16) \ \mu F = 30 \ \mu F \)

To the right of e-f: \( C_{ef} = \frac{60 \times 30}{60 + 130} \ \mu F = 20 \ \mu F \)

\[ V_{30} = 90 \ V \]

\[ V_{60} = \frac{90 \times 30}{30 + 60} = 30 \ V \]

\[ V_{14} = 60 \ V \] - KVL

\[ V_{20} = \frac{100 \times 80}{80 + 20} = 48 \ V \]

\[ V_{80} = 12 \ V \]

\[ V_{60} = \frac{100 \times 30}{40} = 75 \ V \]

\[ V_{14} = \frac{100 \times 60}{40} = 150 \ V \]

\[ V_{20} = \frac{150 \times 80}{100} = 120 \ V \]

\[ V_{80} = \frac{150 \times 20}{100} = 30 \ V \]