1. For the circuit shown do not solve any equations (25 points).
   
   a) Write the nodal equations for $v_1$ and $v_2$. Your equations should only be in terms of $v_1$ and $v_2$.

   \[
   \frac{v_1 - 24}{4} + \frac{v_1}{4} + \frac{v_1 - v_2}{8} = -3
   \]

   \[
   \frac{v_2 - v_1}{8} + \frac{v_2 + (24 - v_1)}{2} = 3
   \]

   b) Write the mesh equations for $i_1$, $i_2$ and $i_3$. Your equations should only be in terms of $i_1$, $i_2$ and $i_3$.

   \[
   4i_1 + 4(i_1 - i_3) = 24
   \]

   \[
   8i_2 + 2i_3 - 4i_1 + 4(i_3 - i_1) = 0
   \]

   \[
   i_3 - i_2 = 3
   \]
2. The following questions have to be solved using the specified method.

a) Using source transformations reduce the circuit shown to a one mesh circuit and solve for $v_x$ (15 points).

\[ 12V = v_x + 10 \times \frac{v_x}{1} + v_x = 12v_x \]
\[ \Rightarrow v_x = 1V \]

b) Using the superposition principle calculate the voltage $v_y$ for the circuit shown (15 points).

$I_s = 0$:

\[ v_{y1} = \frac{2}{2 + 2} (4) = 2V \]

$v_s = 0$

\[ v_{y2} = 1(2+1) = 3V \]

\[ \therefore v_y = v_{y1} + v_{y2} = 2 + 3 = 5V \]
3. For the circuit shown (20 points).
   a) Calculate the value of R for maximum power transfer. Hint: Use Thevenin’s equivalent circuit as seen by R.

   \[ V_{th} \]
   \[
   \begin{array}{c}
   \text{V}_{th} = 10 \Omega \\
   50 \text{V} \\
   \frac{3}{4} \text{V}_x \end{array}
   \quad \begin{array}{c}
   \text{R} \\
   40 \Omega \\
   \frac{3}{4} \text{V}_x
   \end{array}
   \]

   \[ V_{oc} = V_x - \frac{3}{4} V_x = \frac{1}{4} V_x \]
   \[ V_x = \frac{40}{10+40} \times 50 = 40 \text{ V} \Rightarrow V_{oc} = \frac{1}{4} \times 40 = 10 \text{ V} \]

   \( I_{sc} \)
   From KVL \[ \frac{3}{4} V_x = V_x \Rightarrow V_x = 0 \]
   \[ I_{sc} = \frac{50}{10} = 5 \Omega \]

   \[ R_{th} = \frac{V_{th}}{I_{sc}} = \frac{10}{5} = 2 \Omega \]

   For maximum power transfer \( R = R_{th} = 2 \Omega \)

b) Calculate the maximum power delivered to R.

   \[ P_{max} = \frac{V_{th}^2}{4R_{th}} = \frac{10 \times 10}{4 \times 2} = 12.5 \text{ W} \]