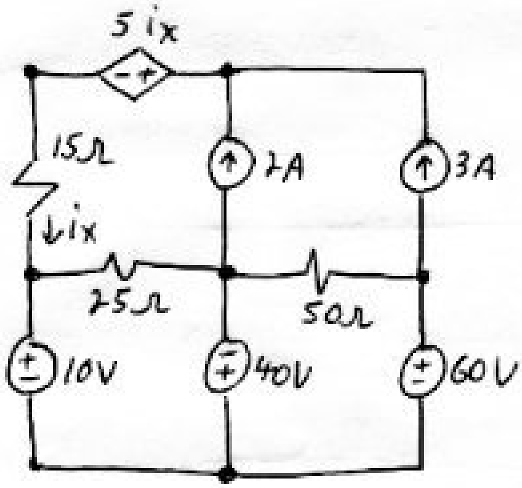
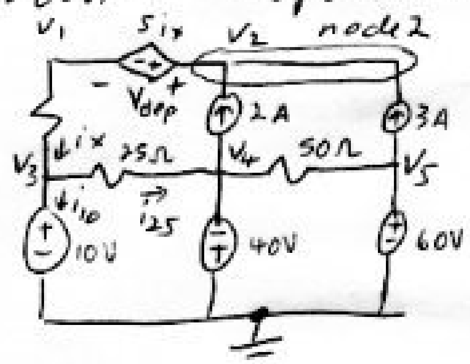
Q1



(a) Find all node voltages.

(b) Find power for the dependent source and for the 10V source, specifying if power is supplied or absorbed.

Soln 1 Inspection:



$i_x = 2A + 3A$ (KCL at Node 2)

$\Rightarrow V_1 = 10V + i_x \times 15\Omega = 85V$

$V_2 = V_1 + 5i_x = 85 + 25 = 110V$

$V_3 = 10V \quad V_4 = -40V \quad V_5 = 60V$ (all given)

$P_{dep} = (V_{dep})(i_x)$ (passive notation)

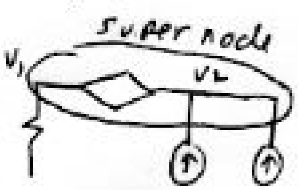
$= (5i_x)(i_x) = 25V \times 5A = +125W$ absorb.

$P_{10} = 10V(i_{10})$ (passive notation)

$= 10V(i_x - i_{25}) = 10V(5A - \frac{10V + 40V}{25\Omega})$

$= 10V(5A - 2A) = 30W$ absorb

Soln 2 Node Method:



controller: $i_x = \frac{V_1 - 10V}{15}$ (1)

super node KCL: $\frac{V_1 - 10}{15} - 2 - 3 = 0$ (2)

constraint: $5i_x = V_2 - V_1$ (3)

solving (2) $\Rightarrow V_1 = 85V$

(1) $\Rightarrow i_x = \frac{85 - 10}{15} = 5A$

(3) $\Rightarrow 5 \times 5 = V_2 - V_1 \Rightarrow V_1 = 85 + 25 = 110V$

Check: First use KCL & Ohm's Law to find branch currents

- 40V: −80W supplied
- 60V: −300W "
- 2A: −300W "
- 1A: −150W "
- 10V +30W absorb
- 5ix +125W

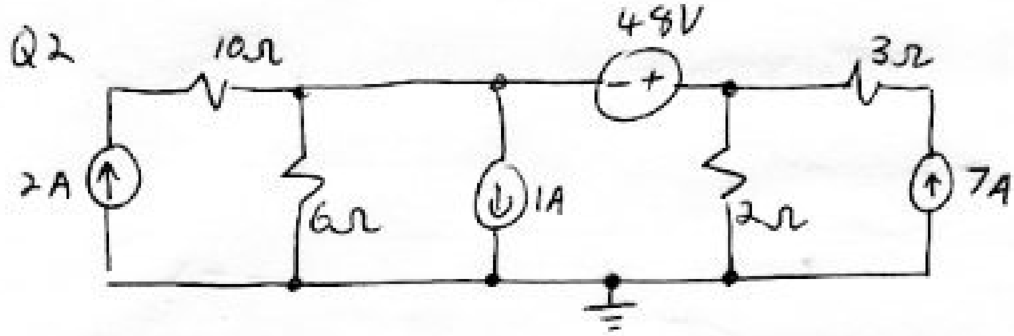
675W supplied

$\Sigma i^2R = 5^2 \times 15 + 2^2 \times 25 + 2^2 \times 50$

675W absorbed

Energy is conserved :)

Q2



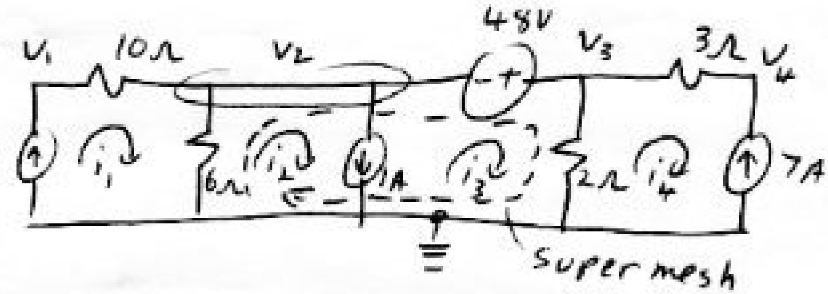
(a) Find all mesh currents.

(b) Using the results of part (a) find all node voltages.

(c) Find power for each source, Specify absorbed/supplied.

(d) Calculate total power absorbed by the resistors.

Soln:



loop 1 $\underline{i_1 = 2A}$ (given) (1) loop 4: $\underline{i_4 = -7A}$ (given) (2)

Super loop KVL: $6(i_2 - 2) - 48V + 2(i_3 + 7) = 0$ (3)

constraint: $1A = i_2 - i_3$ or $i_2 - i_3 = 1$ (4)

Solving these eqns: from (3): $6i_2 + 2i_3 = 46$ (5)

$2 \times (4) + (5)$: $8i_2 = 48 \Rightarrow \underline{i_2 = 6A}$

From (4): $\underline{i_3 = 5A}$

(b) $V_3 = iR = (i_3 - i_4) \times 2\Omega = 12 \times 2 = 24V$

$V_4 = V_3 - i_4 \times 3\Omega = 24 - (-7 \times 3) = 45V$

$V_2 = (i_1 - i_2) \times 6\Omega = -24V$ or $V_2 = V_3 - 48V = -24V$

$V_1 = V_2 + i_1 \times 10\Omega = -24 + 2 \times 10 = -4V$

(c) 2A: $P = -V_1 i_1 = -(-4)(2) = +8W$ absorb

1A: $P = V_2 \times 1A = -24 \times 1 = -24W$ supplied

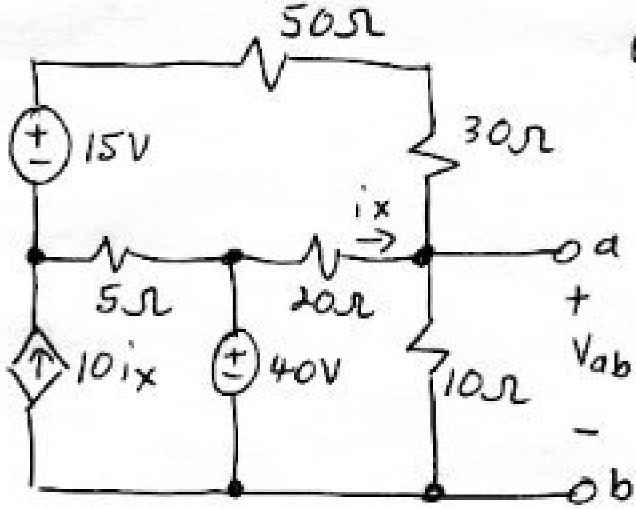
48V: $P = -48 \times i_3 = -48 \times 5 = -240W$ supplied

7A: $P = -V_4\, 7A = -(45) \times 7 = \underline{-315W}$ supplied

$P_{source\ total} = 571W$ supplied

(d) $\therefore \sum i^2 R = 571W$ By conserv. of Energy.

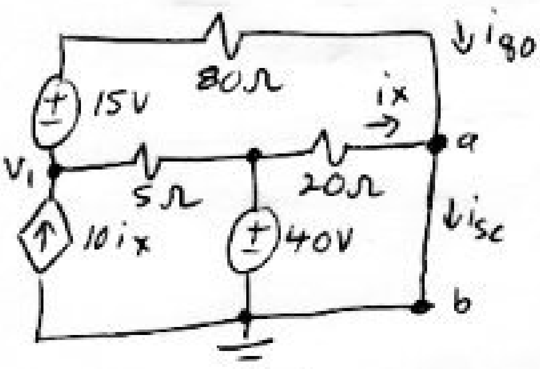
Q3



(a) A voltmeter is connected to terminals a and b (acting like a resistor of infinite Ohms) and Vab is measured to be $V_{ab} = +20V$. Determine the Thevenin Equivalent circuit for terminals a and b of the given circuit.

(b) Predict Vab if a resistor is now placed across terminals a & b for (i) $R_{ab} = 2.25Ω$
(ii) $R_{ab} = 7.85Ω$
(iii) $R_{ab} = 47Ω$

Soln $V_{oc} = 20V$
so just need I_{sc}:



$i_x = \frac{40V}{20Ω} = 2A$

$10i_x = 20\ A$

Node 1: $-20A + \frac{V_1 - 40V}{5Ω} + \frac{V_1 + 15V}{80Ω} = 0 \overset{\times 80Ω}{\Rightarrow} -1600 + 16V_1 - 640 + V_1 + 15 = 0$

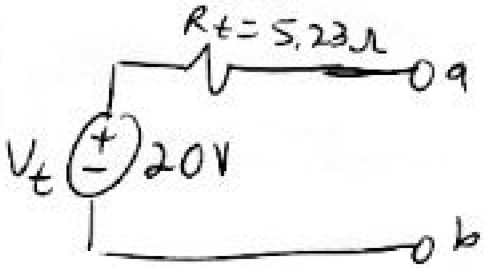
or $17V_1 = 2225V$

$V_1 = 130.88V$

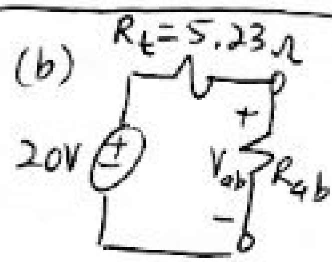
$\therefore i_{80} = \frac{V_1 + 15V}{80Ω} = \frac{130.88 + 15}{80} = 1.8235A$

$\therefore I_{sc} = i_x + i_{80} = 2 + 1.835 = 3.8235A \Rightarrow R_t = \frac{V_{oc}}{I_{sc}} = 5.23\ Ω$

Thev Circ:



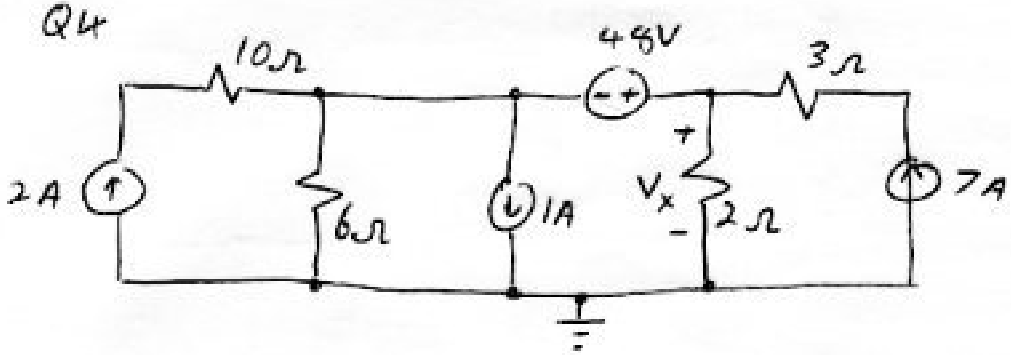
(b)



$V_{ab} = 20V \times \frac{R_{ab}}{R_t + R_{ab}}$

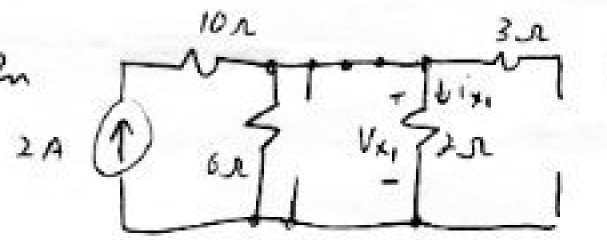
(i) 6V
(ii) 12V
(iii) 18V

Q4



For this circuit (it is exactly the same circuit as in problem Q2), calculate V_x using the principle of superposition.

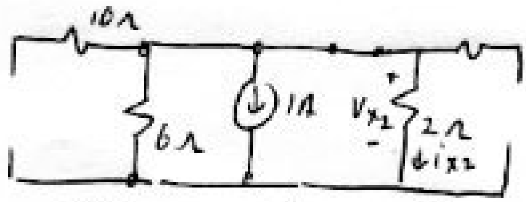
Soln



By current division

$i_{x1} = 2A \times \frac{6}{6+2} = 1.5A$

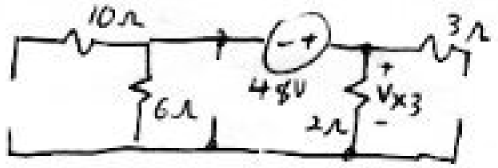
$\therefore V_{x1} = 1.5 \times 2\Omega = \underline{3V}$



By current division

$i_{x2} = -1A \times \frac{6}{6+2} = -0.75A$

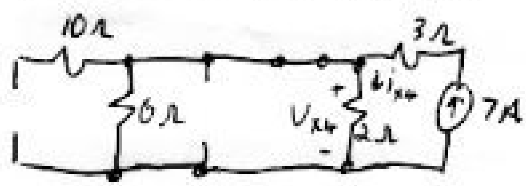
$\therefore V_{x2} = -.75 \times 2 = \underline{-1.5V}$



Note the 2Ω R is in series with the 6Ω R.

$\therefore$ By voltage division

$V_{x3} = 48 \times \frac{2}{2+6} = \underline{12V}$



By current division

$i_{x4} = 7A \times \frac{6}{6+2} = 5.25A$

$\therefore V_{x4} = 5.25A \times 2\Omega = \underline{10.5V}$

Total voltage: $V_x = V_{x1} + V_{x2} + V_{x3} + V_{x4} = \underline{\underline{24V}}$

This agrees with ans in Q2: $V_3 = V_x = 24V.$