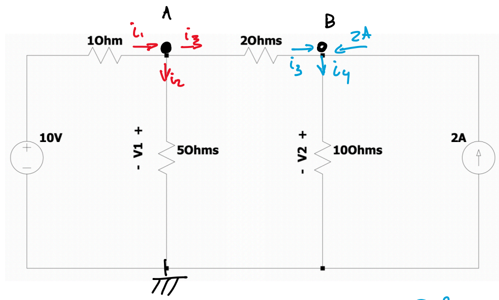
Homework 2

Friday, October 4, 2024 10:28 PM

Problem 1. Compute the voltages **V1** and **V2** in the circuit shown in Fig. 1 using the Kirchoff's laws (KCL, KVL) and Ohm's law only.



KCL @ A

$i_1 - i_2 - i_3 = 0$

$$\frac{10 - V_1}{1\Omega} - \frac{V_1 - 0}{5} - \frac{V_1 - V_2}{2} = 0$$

$$10 - V_1 - \tfrac{1}{5}V_1 - \tfrac{1}{2}V_1 + \tfrac{1}{2}V_2 = 0$$

$$10 + \tfrac{1}{2}V_2 = V_1 + \tfrac{1}{5}V_1 + \tfrac{1}{2}V_1$$

$$\tfrac{17}{10}V_1 - \tfrac{1}{2}V_2 = 10$$

$$\boxed{\begin{aligned} V_1 &= 100/11 = 9.09\,V \\ V_2 &= 120/11 = 10.91\,V \end{aligned}}$$

KCL @ B

$i_3 + 2 - i_4 = 0$

$$\frac{V_1 - V_2}{2} + 2 - \frac{V_2 - 0}{10} = 0$$

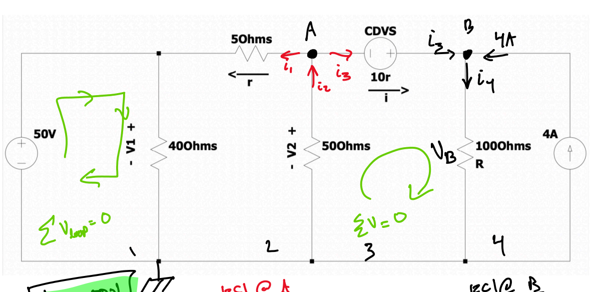
$$\tfrac{1}{2}V_1 - \tfrac{1}{2}V_2 - \tfrac{1}{10}V_2 + 2 = 0$$

$$\tfrac{1}{2}V_1 - \tfrac{6}{10}V_2 = -2$$

$$\left[\begin{array}{cc|c} 17/10 & -1/2 & 10 \\ 1/2 & -6/10 & -2 \end{array}\right]$$

Problem 2. Compute the voltages V1 and V2 in the circuit shown in Fig. 2 using the Kirchoff's laws (KCL, KVL) and Ohm's law only.

Note the "CDVS" in Fig. 2 denotes *current-dependent-voltage-source*.



$\boxed{V_1 = 50V}$

KVL on loop 3

$$V_2 + 10\left(\frac{V_2 - 50}{5}\right) - V_B = 0$$

$$V_2 + 2V_2 - 100 - V_B = 0$$

KCL @ A

$i_2 - i_1 - i_3 = 0$

$$\frac{V_2 - 0}{50} - \left(\frac{V_1 - V_2}{5}\right) - i_3 = 0$$

$$\frac{V_2}{50} + \frac{V_2 - 50}{5} - i_3 = 0$$

$$\frac{V_2}{50} + \tfrac{1}{5}V_2 - 10 - i_3 = 0$$

KCL @ B

$i_3 - i_4 + 4 = 0$

$$i_3 - \frac{V_B}{100} + 4 = 0$$

$$\begin{array}{cccc} V_2 & V_B & i_3 & b \end{array}$$
$$\left[\begin{array}{ccc|c} 3 & 1 & 0 & 100 \\ 1/50 & 0 & 1 & 10 \\ -1/ & & & \end{array}\right] \Rightarrow$$

$\boxed{V_2 = 68.42\,V}$

$V_B = 105.26\,V$

$i_3 = 5.05\,A$

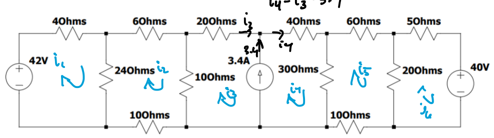
$\begin{bmatrix} 0 & 100 & 1 & 1 & -4 \end{bmatrix}$

Problem 3. Compute the power associated with the 42V voltage supply in Fig. 3.

kcl

$i_3 + 3.4 - i_4 = 0$

$i_4 - i_3 = 3.4$



mesh 1

$4i_1 + 24(i_1 - i_2) = 42$

$28i_1 - 24i_2 = 42$

mesh 2

$24(i_2 - i_1) + 6i_2 + 10(i_2 - i_3) + 10i_2 = 0$

$24i_2 - 24i_1 + 6i_2 + 10i_2 - 10i_3 + 10i_2 = 0$

$-24i_1 + 50i_2 - 10i_3 = 0$

mesh 3 + 4

$10(i_3 - i_2) + 20i_3 + 4i_4 + 30(i_4 - i_5) = 0$

$30i_3 - 10i_2 + 34i_4 - 30i_5 = 0$

mesh 5

$30(i_5 - i_4) + 6i_5 + 20(i_5 - i_6) + 10i_5 = 0$

$66i_5 - 30i_4 - 20i_6 = 0$

mesh 6

$20(i_6 - i_5) + 5i_6 = -40$

$25i_6 - 20i_5 = -40$

$$\begin{array}{ccccccc} i_1 & i_2 & i_3 & i_4 & i_5 & i_6 & b \end{array}$$

$$\begin{bmatrix} 28 & -24 & 0 & 0 & 0 & 0 & 42 \\ 0 & 0 & -1 & 1 & 0 & 0 & 3.4 \\ -24 & 50 & -10 & 0 & 0 & 0 & 0 \\ 0 & -10 & 30 & 34 & -30 & 0 & 0 \\ 0 & 0 & 0 & -30 & 66 & -20 & 0 \\ 0 & 0 & 0 & 0 & -20 & 25 & -40 \end{bmatrix}$$

Solved in matlab

$i_1 = 2.12A$

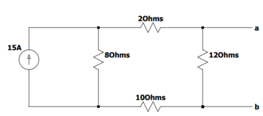
$P = iV$

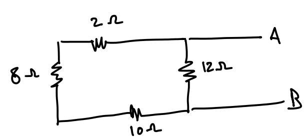
$P_{42} = 2.12 \cdot 42 = 89.04$ W

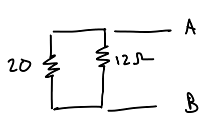
Problem 4. With clear derivations and corresponds circuits, find the Norton equivalent circuit with respect to the terminals a, b for the circuit shown in Fig. 4.

R_n ✓

I_n ✓





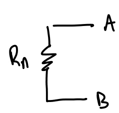


$\left(\frac{1}{20} + \frac{1}{12}\right)^{-1}$

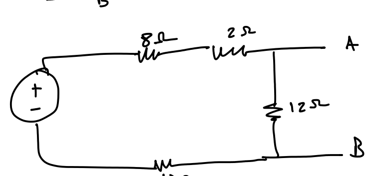
$\left(\frac{3}{60} + \frac{5}{60}\right)^{-1}$

$\frac{60}{8} = 7.5\Omega$

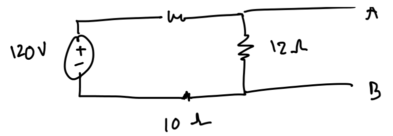
$R_N = 7.5\ \Omega$

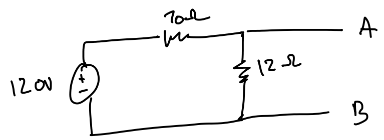


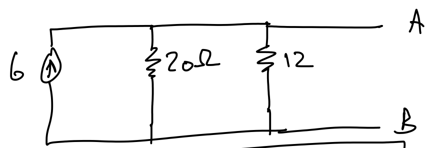
$15 \cdot 8$

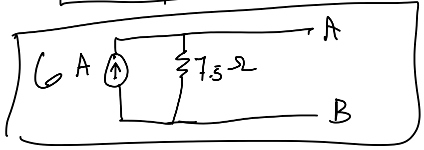


10Ω

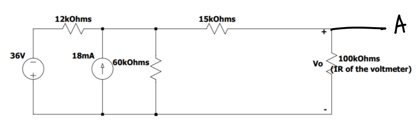


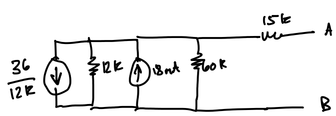


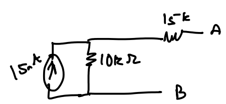


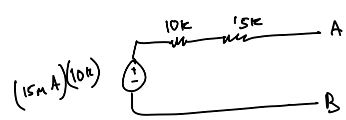


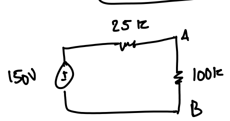
Problem 5. A Voltmeter with an internal resistance (IR) of 100K Ohms is used to measure the voltage V_0 in the circuit shown in Fig. 5 below. With clear derivations and corresponds circuits, find the Voltmeter reading for V_0 using the source transform method.



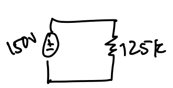








$i = \frac{150\,V}{125k\,\Omega}$

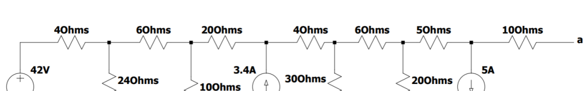


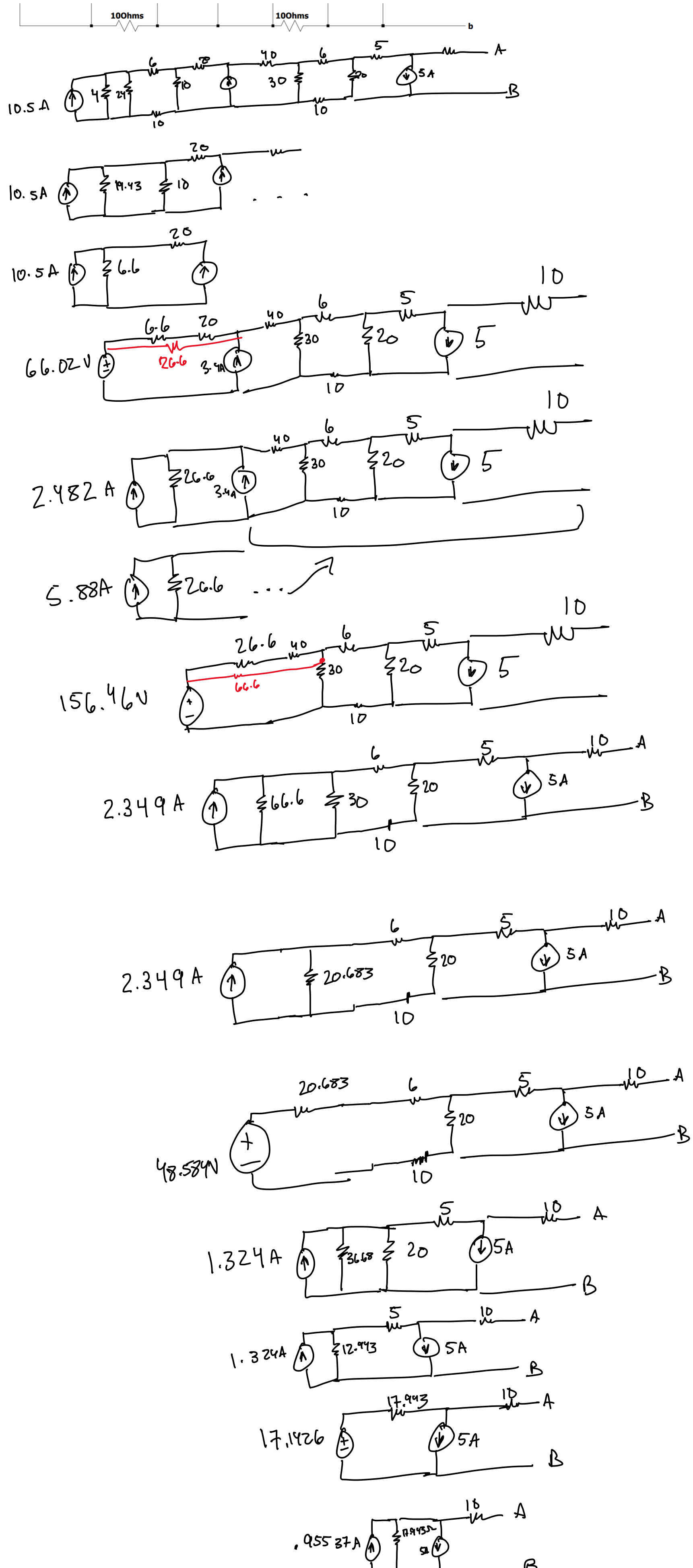
$V_{AB} = 150 - 25k\left(\frac{150V}{125k}\right)$

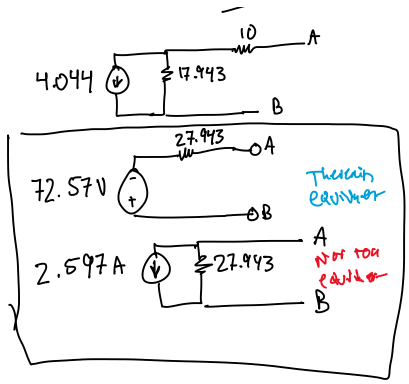
$\boxed{= 120\,V}$

Problem 6. With clear derivations and corresponds circuits, find the Thevenin and Norton equivalent circuits with respect to the terminals a, b for circuit shown in Fig. 6.

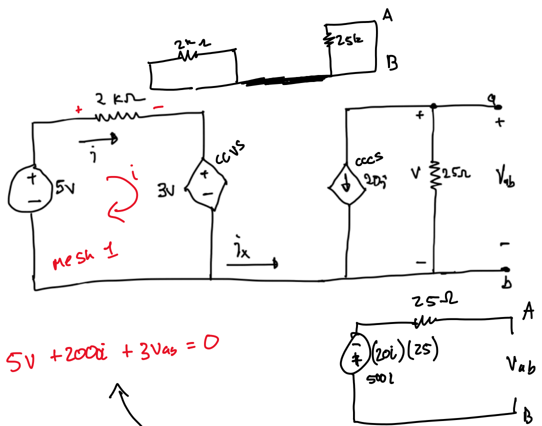
$R_N = 27.1797\ \Omega$




10Ohms
10Ohms
b
10.5 A
A
B
5A
10.5A
19.43
10.5A
6.6
66.02V
26.6
3.4A
2.482 A
5.88A
156.46V
66.6
2.349A
20.683
48.584V
1.324A
3.668
12.443
17.1426
17.443
.95537A



Problem 7. Derive the Thevenin and Norton equivalent circuits from the circuit shown below.



$$-5V + 2000i + 3V_{ab} = 0$$

$$V_{ab} = 500i$$

$$i = \frac{V_{ab}}{500}$$

$$-5V + 2000\left[\frac{V_{ab}}{500}\right] + 3V_{ab}$$

$$7V_{ab} = 5$$

$$V_{ab} = \frac{5}{7}V$$

$$i = \frac{5}{7} \cdot \frac{1}{500} = \frac{1}{700} = .0014285A$$