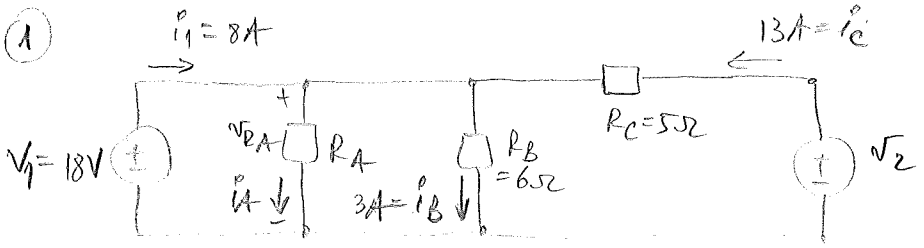
Review for Exam 1

Score: Don → 0 → 10/20

(1)



nodes = ?
branches = ? , # loops = ?
R_A = ?

nodes = 3
branches = 5
loops = 6.

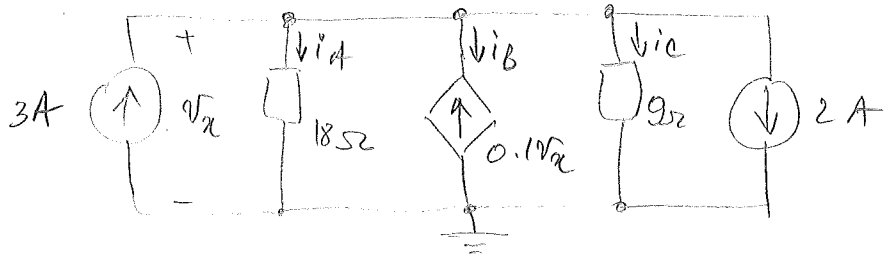
$i_1 + i_C = i_A + i_B$

$i_A = i_1 + i_C - i_B = (8 + 13 - 3)\,A = 18\,A$

$v_{RA} = V_1 = 18V$

$\Rightarrow R_A = \frac{v_{RA}}{i_A} = \frac{18V}{18A} = 1\Omega$

(2) Find i_A, i_B, i_C ⊗ do this



KCL for upper node:

$3A = i_A + i_B + i_C + 2A$

$3A = \frac{v_x}{18\Omega} - 0.1 v_x + \frac{v_x}{9\Omega} + 2A$

$1 = \frac{v_x - 1.8 v_x + 2 v_x}{18}$

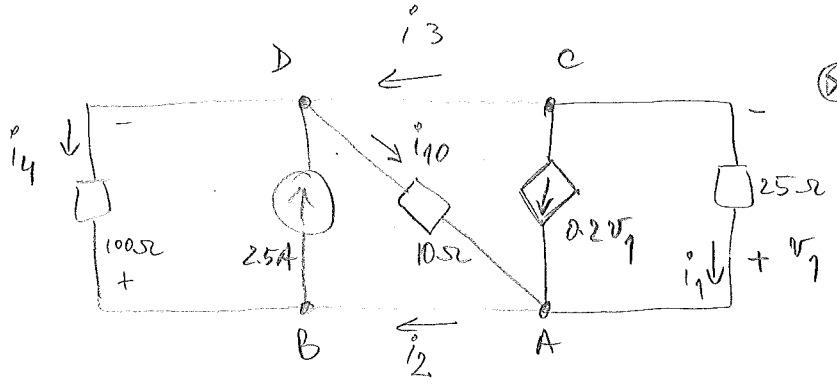
$18 = 1.2 v_x \Rightarrow v_x = \frac{18}{1.2} V$

$i_A = \frac{v_x}{18\Omega} = \frac{18}{1.2} \cdot \frac{1}{18} A = \frac{1}{1.2} A$

$i_B = -0.1 v_x = -0.1 \times \frac{18}{1.2} A = -\frac{1.8}{1.2} A$

$i_C = \frac{v_x}{9\Omega} = \frac{18}{1.2} \cdot \frac{1}{9} A = \frac{2}{1.2} A$

(3)



⊗ do this $i_1, i_2, i_3, i_4 = ?$

KCL B: $i_2 + i_4 = 2.5A \Rightarrow i_2 = 2.5A - i_4$

KCL A: $i_1 + i_{10} + 0.2v_1 = i_2 = 2.5A - i_4$

$$-\frac{v_1}{25} - \frac{v_1}{10} + 0.2v_1 = 2.5 - \left(-\frac{v_1}{100}\right)$$

$$-4v_1 - 10v_1 + 20v_1 = 250 + v_1$$

$$5v_1 = 250 \Rightarrow \boxed{v_1 = 50\,[V]}$$

$$i_1 = -\frac{v_1}{25} = -\frac{50}{25}A = -2A$$

$$i_4 = -\frac{v_1}{100} = -\frac{50}{100}A = -0.5A$$

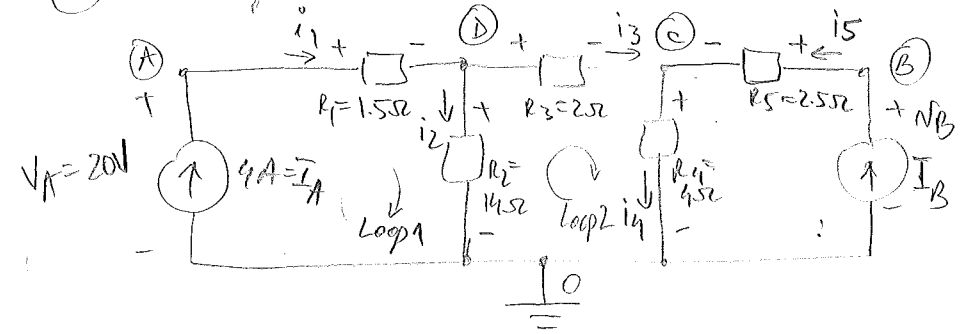
$$i_{10} = -\frac{v_1}{10} = -\frac{50}{10}A = -5A$$

$$i_2 + i_4 = 2.5A \Rightarrow i_2 = 2.5A - i_4 = 2.5A - (-0.5A) = 3A$$

$$i_3 + i_1 + 0.2v_1 = 0$$

$$i_3 = -i_1 - 0.2v_1 = 2A - (0.2 \times 50)A = (2 - 10)A = -8A.$$

(4) Find power absorbed by each of the circuit elements: ⊗ do this



Note that:

$v_A = V_A = 20V$

$v_D = v_{R2}$

$v_C = v_{R4}$

KVL Loop 1:

$V_A = v_{R_1} + v_{R_2}$

$20\,V = i_1 R_1 + v_{R_2} = \underbrace{4A \times 1.5\Omega}_{6V} + v_{R_2} \Rightarrow \boxed{v_{R_2} = 14\,V}$

$\boxed{v_{R_1} = 6V}$

$i_2 = \frac{v_{R_2}}{R_2} = \frac{14\,V}{14\Omega} = \boxed{1A = i_2}$

KVL Loop 2: $v_{R_2} = v_{R_3} + v_{R_4} = R_3 \cdot i_3 + v_{R_4} \overset{\text{KCL node D}}{=}$

$= R_3 (i_1 - i_2) + v_{R_4} = 2\,(4-1)\,V + v_{R_4}$

$= 6\,V + v_{R_4} \Rightarrow v_{R_4} = v_{R_2} - 6\,V = (14-6)\,V = 8\,V$

$\boxed{v_{R_4} = 8\,V}$ $\quad i_4 = \frac{v_{R_4}}{R_4} = \frac{8\,V}{4\Omega} = 2A.$

$\boxed{i_4 = 2A}$

$\boxed{i_3 = 3A}$

$\boxed{v_{R_3} = 6V}$

KCL node C: $i_3 + i_5 = i_4$

$i_5 = i_4 - i_3 = 2A - 3A = \boxed{-1A = i_5} = I_B$

$v_B = v_{R_5} + v_{R_4} = \underbrace{-1A \times 2.5\Omega}_{= v_B} + 2A \times 4\Omega = (8 - 2.5)\,V = 5.5\,V$

Power absorbed:

I_A: $P_A = V_A \times (-I_A) = -20\,V \times 4A = -80\,W$ (delivered!)

I_B: $P_B = v_B \times (-I_B) = 5.5\,V \times (+1A) = 5.5\,W$

R_1: $P_1 = v_{R_1} \cdot i_1 = 6V \cdot 4A = 24\,W$

R_2: $P_2 = v_{R_2} \cdot i_2 = 14V \cdot 1A = 14\,W$

R_3: $P_3 = v_{R_3} \cdot i_3 = 6V \cdot 3A = 18\,W$

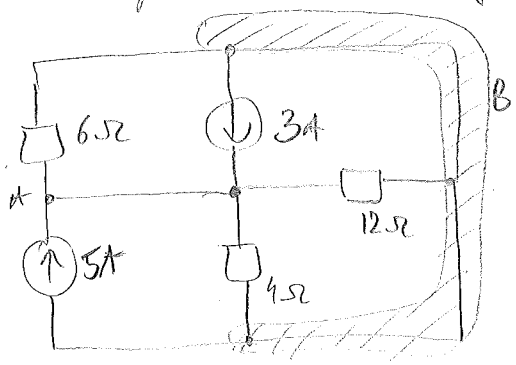
R_4: $P_4 = v_{R_4} \cdot i_4 = 8V \cdot 2A = 16\,W$

R_5: $P_5 = v_{R_5} \cdot i_5 = (-2.5V) \times (-1A) = 2.5\,W$

absorbed:

5.5 +
24
14
18
16
2.5
80.0 W = 80 W delivered!

(5) Find the power absorbed by each of the circuit's elements:



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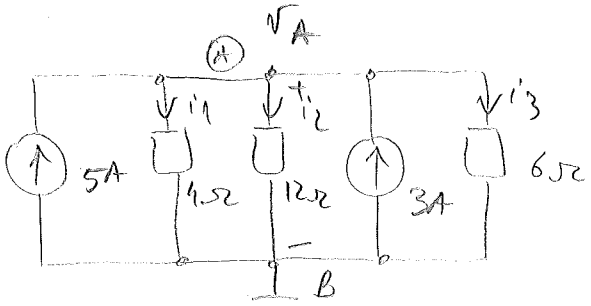


0V = reference node

$$5A + 3A = i_1 + i_2 + i_3$$

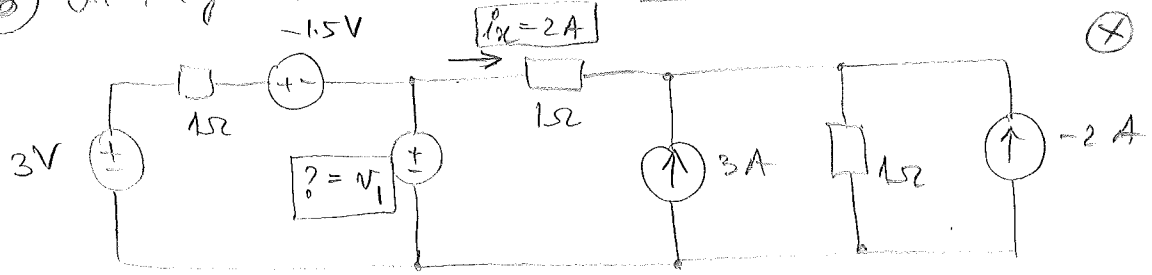
$$= \frac{v_A}{4\Omega} + \frac{v_A}{12\Omega} + \frac{v_A}{3\Omega}$$

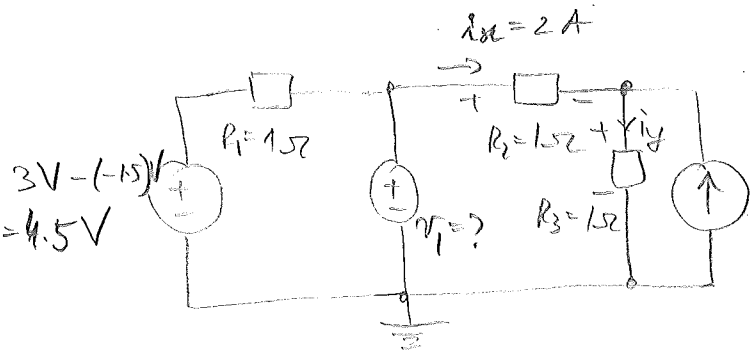
$$8A = \frac{8\,v_A}{12\Omega} \Rightarrow \boxed{v_A = 12\ V}$$

The rest is easy...

(6) In the given circuit, choose v_1 to obtain a current i_x of 2A.

⊗ do this





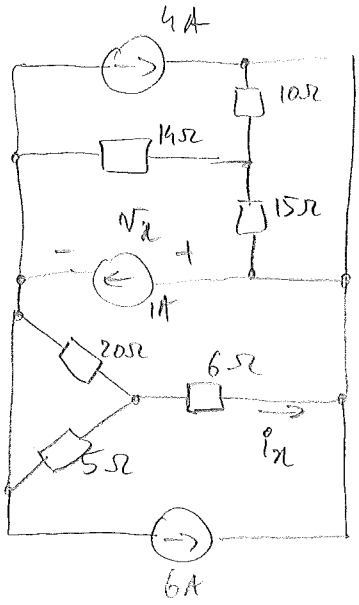
$$v_1 = v_{R_2} + v_{R_3} = i_x \cdot R_2 + R_3 \cdot i_y$$

$$= i_x R_2 + R_3 (i_x + 1A)$$

$$v_1 = \underbrace{(R_2 + R_3)}_{2\Omega}\,\underbrace{i_x}_{2A} + \underbrace{R_3}_{1\Omega} \cdot 1A = 4V + 1V = 5V$$

$$\boxed{v_1 = 5V}$$

(7) Use source or resistor combination techniques to find v_x and i_x.



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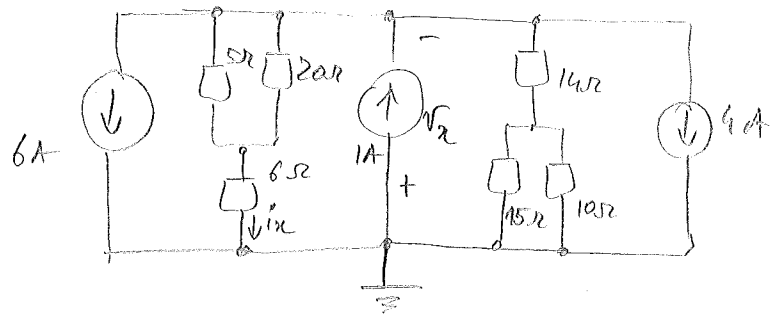

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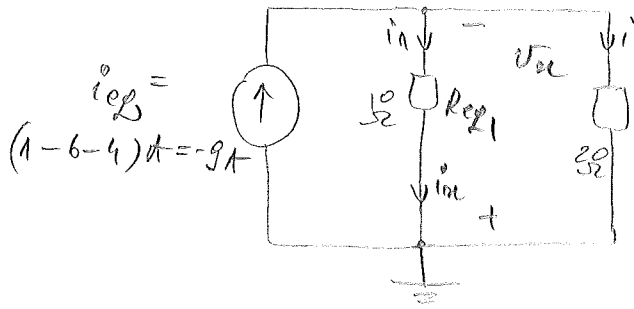

$R_{eq_2} = 14 + (10 \| 15)\,\Omega$
$= (14 + 6)\,\Omega = 20\Omega$

$i_{eq} = i_1 + i_2 = i_{1x} + i_{2x}$ (=)

$R_{eq_1} = 6 + (5 \| 20)\,\Omega$
$= \left(6 + \frac{100}{25}\right)\Omega = 10\Omega$

$$i_{eq} = -\frac{v_x}{R_{eq_1}} - \frac{v_x}{R_{eq_2}}$$

$$-9A = -\frac{2v_x}{10\Omega} - \frac{v_x}{20\Omega} = -\frac{5v_x}{20\Omega}$$

$$\boxed{v_x = 60\,V}$$

$$i_{2x} = -\frac{v_x}{10\Omega} = -\frac{60\,V}{10\Omega} = \boxed{-6\,A = i_x}$$