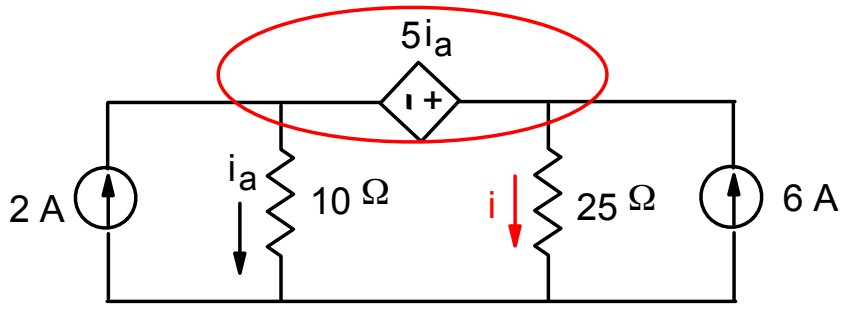
ECE 35 Midterm1 (Spring 2023) **Name**_____

(4 problems, 10 pts each)

1. For the circuit below, calculate the power supplied or absorbed (specify one) by each of the elements.



Solution:

Assume current i in the 25 Ω resistor, apply KCL to the supernode on top:

$2 + 6 = i_a + i \quad \rightarrow \quad i = 8 - i_a$

Apply KVL to the middle loop,

$10\, i_a + 5\, i_a - 25\, i = 0$

$\rightarrow \quad 10\, i_a + 5\, i_a - 25\,(8 - i_a) = 0$

$\rightarrow \quad 40\, i_a - 200 = 0$

$\rightarrow \quad i_a = 5$ A and $i = 3$ A.

Voltage drop across 10 Ω resistor is 50 V.

Voltage drop across 25 Ω resistor is 75 V.

Current through the dependent voltage source is 6 – 3 = 3 A, right to left.

Power absorbed by the 10 W resistor is $10 \times i_a^2 = 250$ W

Power absorbed by the 25 W resistor is $25 \times i^2 = 225$ W

Power supplied by the 2 A source is $2 \times 50 = 100$ W

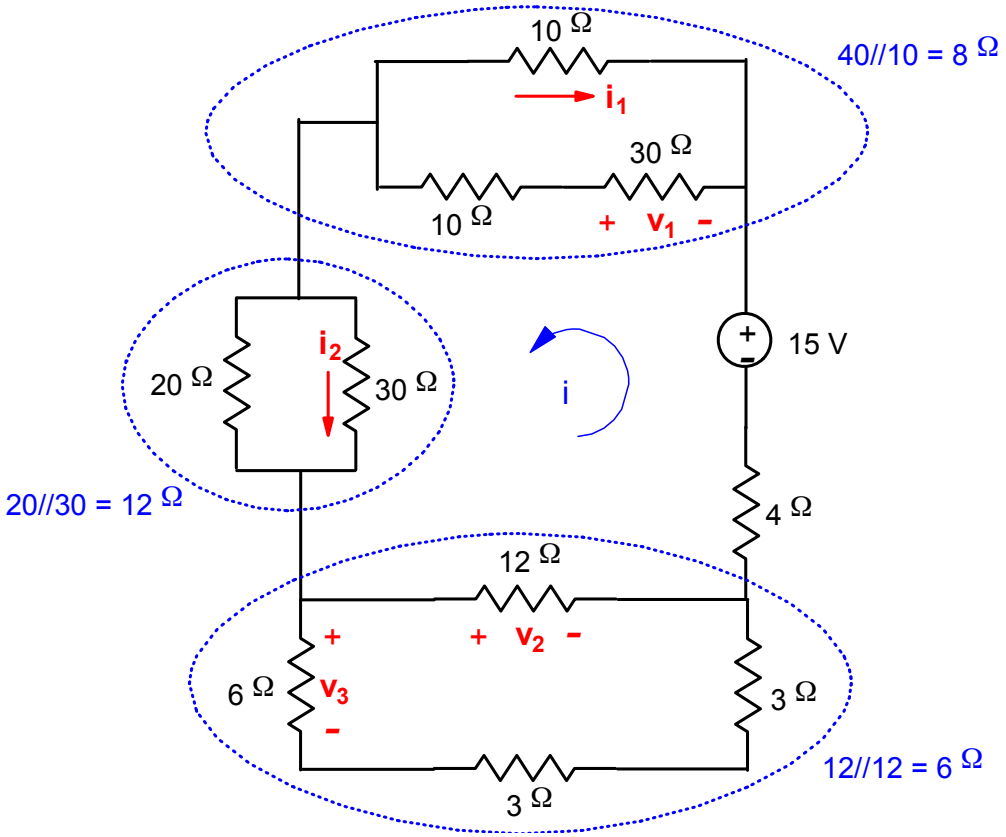
Power supplied by the 6 A source is $6 \times 75 = 450$ W

Power absorbed by the dependent source is $3 \times 5\, i_a = 75$ W

Check: Power supplied = 100 + 450 = 550 W

Power absorbed = 250 + 225 + 75 = 550 W.

2. Find v_1, v_2, v_3, i_1, and i_2. (Include signs and units.)



Solution:

$$i = 15/(8 + 12 + 6 + 4) = 0.5 \text{ A}.$$

Voltage division: $v_1 = -8 \times i \times 30/(30 + 10) = -3$ V.

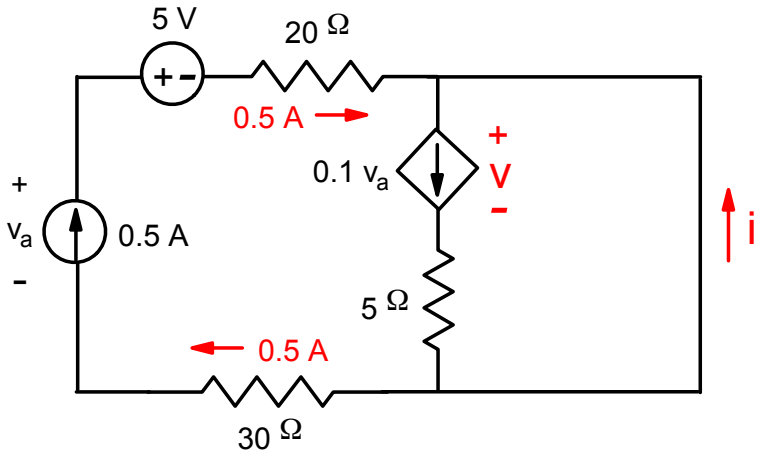
$$v_2 = 6 \times i = 3 \text{ V}.$$

$$v_3 = 6 \times i \times 6/(6 + 3 + 3) = 1.5 \text{ V}.$$

Current division: $i_1 = -i \times 40/(40 + 10) = -0.4$ A.

$$I_2 = i \times 20/(20 + 30) = 0.2 \text{ A}.$$

3. Find i and the power supplied by the dependent current source.



Solution:

KVL entire loop, $v_a - 5 - 0.5 \times 20 - 0.5 \times 30 = 0$

$\rightarrow$ $v_a = 30$ V.

Center current: $0.1 \times v_a = 3$ A.

KCL: $i = 0.1 \times v_a - 0.5 = 2.5$ A.

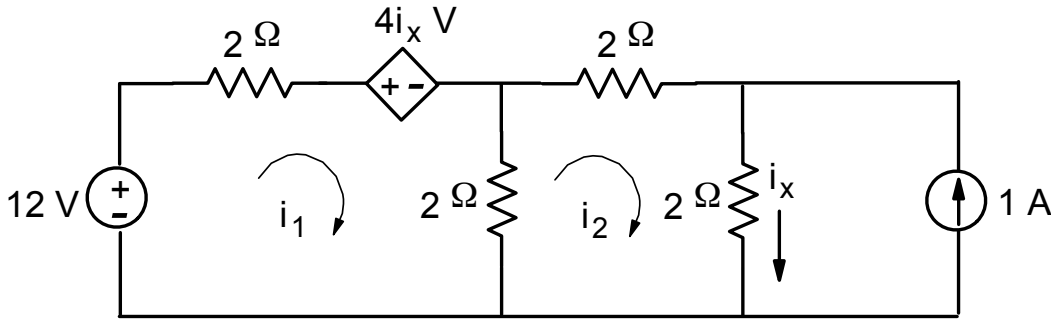
KVL right loop, $5 \times 3 + V = 0$

$\rightarrow$ $V = -15$ V.

Power supplied by the dependent current source is

$0.1\, v_a \times (-V) = 45$ W.

4. Solve the circuit below for i_1, i_2, i_x.



Solution:

$$i_x = i_2 + 1$$

KVL, left loop, $12 - 2\,i_1 - 4\,i_x - 2\,(i_1 - i_2) = 0$

KVL, middle loop, $2\,(i_1 - i_2) - 2\,i_2 - 2\,i_x = 0$

Eliminate i_x from the above eqs.,

$$4 - 2\,i_1 - i_2 = 0$$

$$i_1 - 3\,i_2 - 1 = 0$$

Solve $i_1 = 13/7$ A

$i_2 = 2/7$ A

$i_x = 9/7$ A.