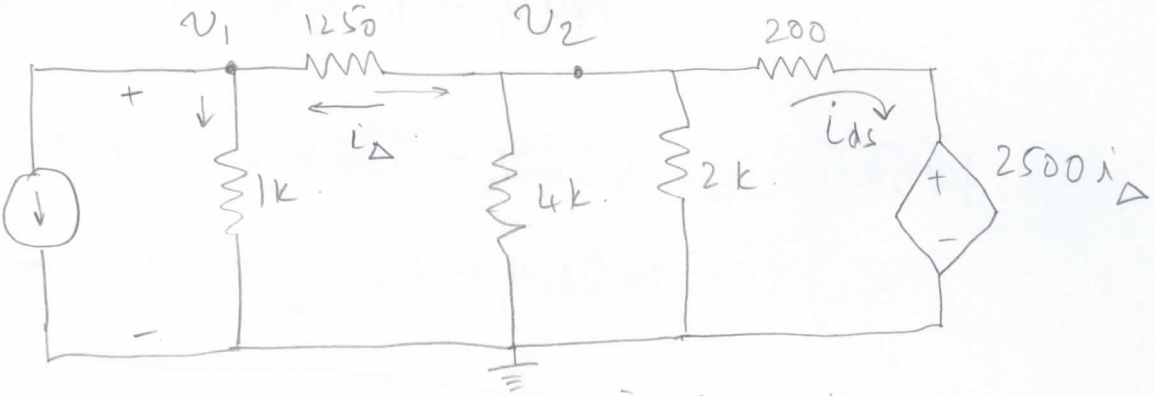
4.19
20 points



Current entering is +ve, leaving is -ve

KCL at Node 1

$$\frac{v_1}{1000} + \frac{v_1 - v_2}{1250} + 20\times10^{-3} = 0 \quad \rightarrow (1)$$

(or) $9v_1 - 4v_2 = -100 \rightarrow (1)$

KCL at Node 2

$$\frac{v_2}{4000} + \frac{v_2}{2000} + \frac{v_2 - 2500 i_\Delta}{200} + \frac{v_2 - v_1}{1250} = 0 \quad \rightarrow (2)$$

Also, $$i_\Delta = \frac{v_2 - v_1}{1250} \rightarrow (3)$$

So (2) becomes:

$$\frac{v_2}{4000} + \frac{v_2}{2000} + \frac{v_2 - 2500(v_2 - v_1)/1250}{200} + \frac{v_2 - v_1}{1250} = 0$$

$$\text{or } \frac{v_2}{4000} + \frac{v_2}{2000} + \frac{v_2 - 2v_2 + 2v_1}{200} + \frac{v_2 - v_1}{1250} = 0$$

$$= \frac{5v_2 + 10v_2 - 100v_2 + 200v_1 + 16v_2 - 16v_1}{20000} = 0$$

$$\text{or } 184v_1 - 69v_2 = 0 \rightarrow (2)$$

Solving ① & ②: $9v_1 - 4v_2 = -100 \rightarrow ①$

$184v_1 - 69v_2 = 0 \rightarrow ②$

$184 \times ①$ $\quad 1656v_1 - 736v_2 = -18400 \rightarrow ①$

$9 \times ②$ $\quad 1656v_1 - 621v_2 = 0 \rightarrow ②$

$-115v_2 = -18400$

or $v_2 = 160$ volts

from ① $\quad 9v_1 - 4*160 = -100$

or $v_1 = 60$ volts

Also $i_\Delta = \frac{v_2 - v_1}{1250} = \frac{160-60}{1250}$

$= 80 \times 10^{-3}$

$= 80$ mAmps

(a) Power

10 $P_{20mA} = Vi = 60 \times 20mA$

$= 1.2$ W (Absorbed, since it is +ve)

$P_{DS} = (2500 i_\Delta) * i_{DS}$ $\quad i_{DS}$ is also Current in 200Ω resistor

so $i_{DS} = \frac{v_2 - 2500 i_\Delta}{200}$ flowing out of node ②

Hence $P_{DS} = 2500 * 80 * 10^{-3} * (-0.2)$

$= -40\,W$

Since this is -ve, it is Power developed

So, total power developed is -40 Watts

(b) Power used:

$P_{used} = P_{20mA} + P_{1K} + P_{1250} + P_{4K} + P_{2K} + P_{200}$

$= 1.2 + \frac{v_1^2}{1000} + 1250 * i_\Delta^2 + \frac{160^2}{4000} + \frac{160^2}{2000} + i_{DS}^2 * 200$

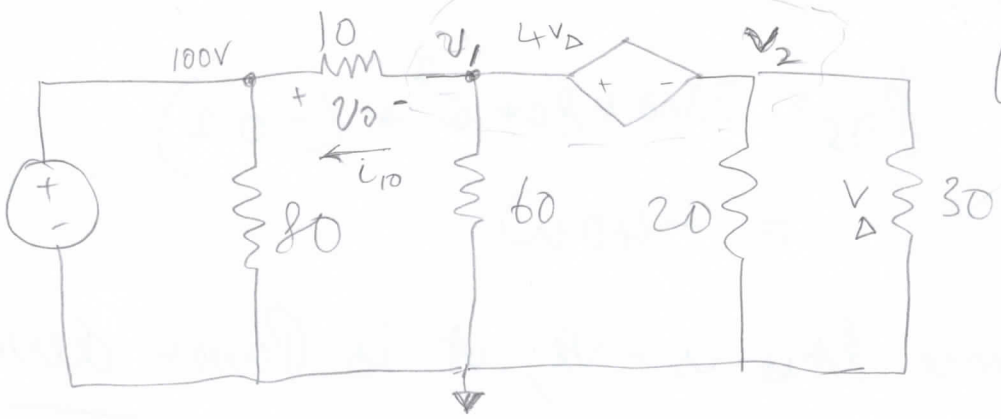
$= 1.2 + \frac{60^2}{1000} + 1250 * 0.08^2 + \frac{160^2}{400} + \frac{160^2}{200} + (-0.2)^2 * 200$

$= 1.2 + 3.6 + 8 + 6.4 + 12.8 + 8$

40 W

4.28

15 points



Imagine a Supernode around the $4v_\Delta$ Source

Supernode KCL

$$\frac{v_1 - 100}{10} + \frac{v_1}{60} + \frac{v_2}{20} + \frac{v_2}{30} = 0$$

or $7v_1 + 5v_2 = 600$ → (1)

KVL

$$-v_1 + 4v_\Delta + v_2 = 0$$

$$v_1 - v_2 = 4v_\Delta$$

Since v_2 is also the same as v_Δ

$$v_1 - v_2 = 4v_2$$

or $v_1 = 5v_2$ → (2)

Use (2) in (1):

(1) becomes: $7v_1 + v_1 = 600$

$8v_1 = 600$

$v_1 = 75$ volts

So $v_2 = 15$ volts

find v_0

We can see that $100 - v_0 = v_1$

So, $v_0 = 100 - v_1$

$= 100 - 75$

$= 25$ volts

(OR)

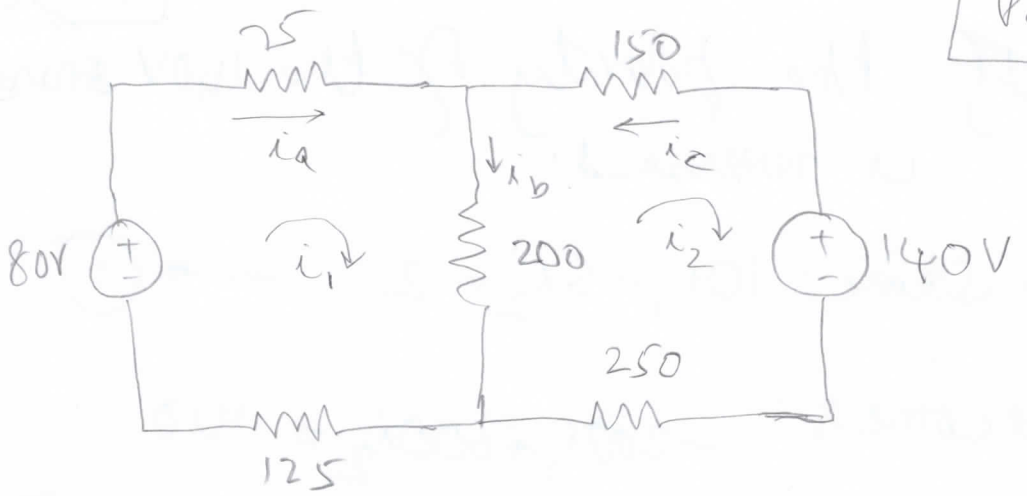
i_{10} is Current leaving Node (1)

$$i_{10} = \frac{v_1 - 100}{10} = \frac{75 - 100}{10} = -2.5 \text{ Amps.}$$

$v_0 = 10(-i_{10}) + 100 = 25$ Volts

4-36

15 points



(a) Find i_a, i_b, i_c

$$i_b = i_1 - i_2 \rightarrow (A)$$

Writing mesh KVL's using i_1 & i_2

Mesh 1 $\quad -80 + 75i_1 + 200(i_1 - i_2) + 125i_1 = 0$

or $\quad 400i_1 - 200i_2 = 80$

or $\quad 20i_1 - 10i_2 = 4$

or $\quad 10i_1 - 5i_2 = 2 \rightarrow (1)$

Mesh 2 $\quad -200(i_1 - i_2) + 150i_2 + 140 + 250i_2 = 0$

or $\quad -200i_1 + 600i_2 = -140$

or $\quad -10i_1 + 30i_2 = -7 \rightarrow (2)$

Add (1) & (2), $\quad 25i_2 = -5$

or $\quad i_2 = -0.2$ Amps.

and so $\quad i_1 = +0.1$ Amps

Branch currents

$i_a = i_1 = 0.1$ A

$i_b = i_1 - i_2 = 0.3$ A

$i_c = -i_2 = 0.2$ Amps

(b) If the polarity of the 140V source is reversed:

(1) is same: $10i_1 - 5i_2 = 2$ ⟶ (1)

(2) becomes: $-200i_1 + 600i_2 = 140$

or $-10i_1 + 30i_2 = 7$ ⟶ (2)

Adding (1) & (2): $25i_2 = 9$

$i_2 = 0.36$ Amps

So $i_1 = 0.38$ "

Branch currents

$i_a = i_1 = 0.38$ A

$i_b = i_1 - i_2 = 0.02$ A

$i_c = -i_2 = -0.36$ A