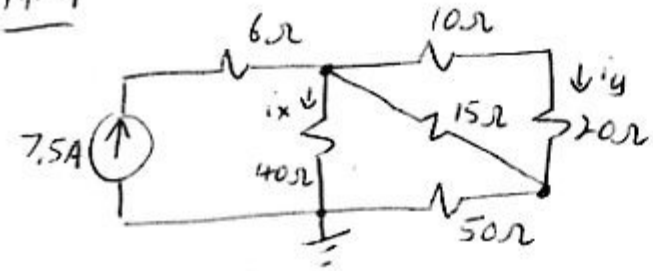
# ENGG 325 Midterm Nov 1 2006

**#1**

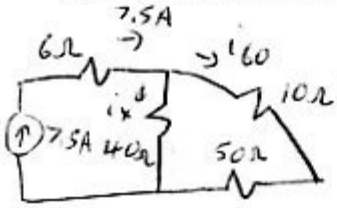



a) Find $i_x$ & $i_y$ by the method of your choice.

b) Find $i_x$ & $i_y$ by another method.

c) What is the resistance "seen" by the 7.5A source (Hint: More than one way to do this)?

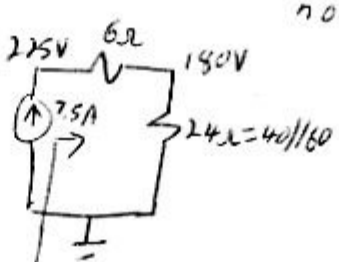
Soln: R combination Inspection Method with current division




$$i_x = 7.5A \times \frac{60}{60+40} = \boxed{4.5A}$$

$$i_{60} = 7.5A \times \frac{40}{40+60} = 3A$$

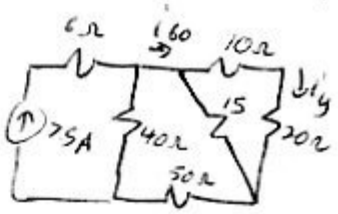
$\Rightarrow$




$R_{seen} = \boxed{30\Omega}$

or $i_{60} = \frac{150V}{60\Omega} = 3A$

now work backward:




$$i_y = i_{60} \times \frac{15}{15+30} = \boxed{1A}$$

Note: other KVL, KCL, Ohm's Law inspection methods possible

**Mesh Method**


$i_1 = 7.5A$ (given) (1)

loop 2: $40(i_2 - i_1) + 15(i_2 - i_3) + 50 i_2 = 0$ (2)

loop 3: $15(i_3 - i_2) + 30 i_3 = 0$ (3)

Now solve (1), (2), (3):

(2) → $-40 i_1 + 105 i_2 - 15 i_3 = 0$

$-40 \times 7.5 + 105 i_2 - 15 i_3 = 0$

$105 i_2 - 15 i_3 = 300$ (4)

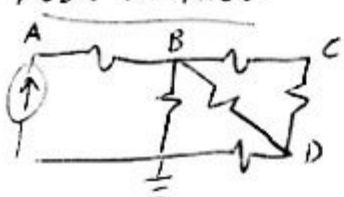
(3) → $-15 i_2 + 45 i_3 = 0$ (5)

3 × (4) + (5): $300 i_2 = 900 \Rightarrow \underline{i_2 = 3A}$ (6)

(6) → (5): $-15 \times 3 + 45 i_3 = 0 \Rightarrow \underline{i_3 = 1A}$ (7)

$\therefore i_x = i_1 - i_2 = \boxed{4.5A}$ $\quad i_y = i_3 = \boxed{1A}$

**Node Method**




Node B: $-7.5 + \frac{V_B}{40} + \frac{V_B - V_D}{15} + \frac{V_B - V_D}{30} = 0$ (1)

Node D: $\frac{V_D - V_B}{15} + \frac{V_D - V_B}{30} + \frac{V_D}{50} = 0$ (2)

$\Rightarrow V_B = 150V$, $V_D = 150V$

$\therefore i_x = \frac{150}{40\Omega} = \boxed{4.5A}$ $\quad i_y = \frac{150V - 150V}{30\Omega} = \boxed{1A}$

Note: By several ways you can find $V_A = 225V$ $\therefore R_{seen} = 225V/7.5A = \boxed{30\Omega}$

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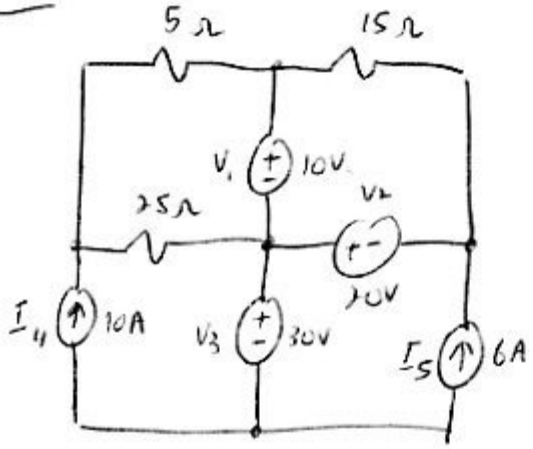
#2



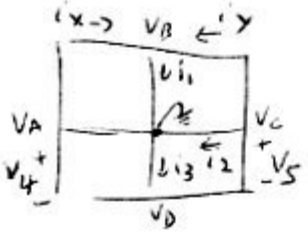

a) Find all node voltages

b) Find power for ~~each~~ the 10A source, specifying if supplied or absorbed. Hint: ans is under 1000W. ☺

c) Find power for the 30V source, specifying if supplied or absorbed, Hint: ans is under 500W.

d) Find Power ... 10 V source ... Hint ans < 100W.

Soln: lots of reasonable nodes for grnd reference, let's choose the centre node as ground.




Given: $V_B = 10V$, $V_C = -20V$, $V_D = -30V$

Node A: $-10 + \frac{V_A}{25} + \frac{V_A - 10}{5} = 0$

$25\times \quad -250 + V_A + 5V_A - 50 = 0$

$6V_A = 300 \Rightarrow V_A = 50V$

(b) 10 A source: $P = -vi$ (active) $= -V_4 \times 10A = -(V_A - V_D)\times 10$
$= -80\times 10$
$= -800W$

6 A source: $P = -vi = -V_5 \times 6 = -(V_C - V_D)\times 6$ supplied
$= -(10)\times 6$
$= -60W$ supplied

10V source: $P = vi = 10V \times i_1$
$= 10\times 6$ ∴ $i_1 = \frac{50-10}{5\Omega} + \frac{(-20V-10V)}{15\Omega} = 8 - 2 = 6A$ ← KCL to Find $i_1$
$= 60W$ absorbed
$i_x = 8A$ $i_y = -2A$

20V source: $P = -vi = -20\, i_2$
$= -20\,(2A + 6A) = -160W$ supplied

30V source: $P = +vi = 30V(I_4 + I_5) = 30\,(16A) = 480W$ absorbed

check $\sum P_{sources} = 480W$ supplied

$\sum i^2R = 320W + 60W + 100W = 480W$ absorbed ✓ good ☺

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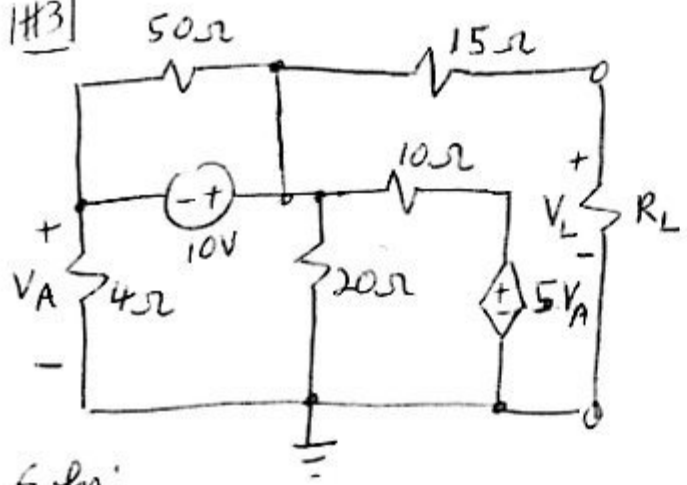
#3



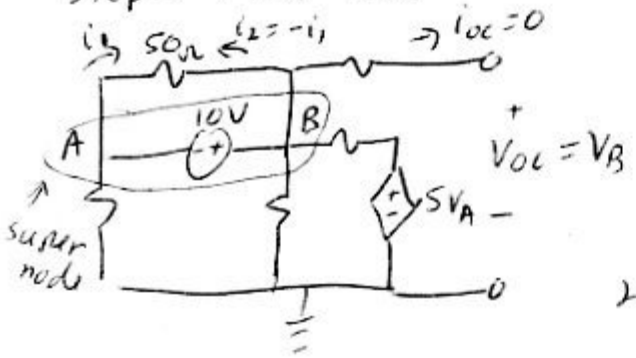

a) Find the Thevenin equivalent circuit to the left of the load resistor $R_L$.

b) Find $V_L$ if

i) $R_L = 1.25\Omega$ ii) $R_L = 7.5\Omega$ iii) $R_L = 20\Omega$

Soln:

Step 1 Find $V_{oc}$




Node Method

Super node: $V_B = 10$

$$\frac{V_A}{4} + \frac{V_A + 10}{20} + \frac{V_A + 10 - 5V_A}{10} = 0$$

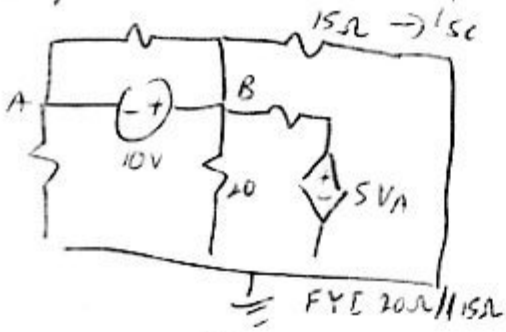
(cancel for 50Ω: $i_1 + i_2$)

20×: $5V_A + V_A + 10 - 8V_A + 20 = 0$

$-2V_A = -30V \Rightarrow V_A = 15V$

$\therefore V_t = V_{oc} = V_B = 15 + 10 = \boxed{25V}$

Step 2 Find $I_{sc}$:




Super node:

$$\frac{V_A}{4} + \frac{V_A + 10}{20} + \frac{V_A + 10 - 5V_A}{10} + \frac{V_A + 10}{15} = 0$$

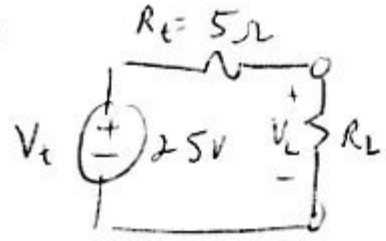
60× $15V_A + 3V_A + 30 - 24V_A + 60 + 4V_A + 40 = 0$

$-2V_A = -130 \Rightarrow V_A = 65V$

$\therefore V_B = V_A + 10 = 75V \quad \therefore i_{sc} = \frac{V_B}{15} = \boxed{5A}$

Step 3 $R_t = \frac{V_{oc}}{I_{sc}} = 5\Omega$

(b)




$$V_L = 25 \times \frac{R_L}{5 + R_L}$$

| $R_L$ | $V_L$ |
|---|---|
| 1.25Ω | 5V |
| 7.5Ω | 15V |
| 20Ω | 20V |

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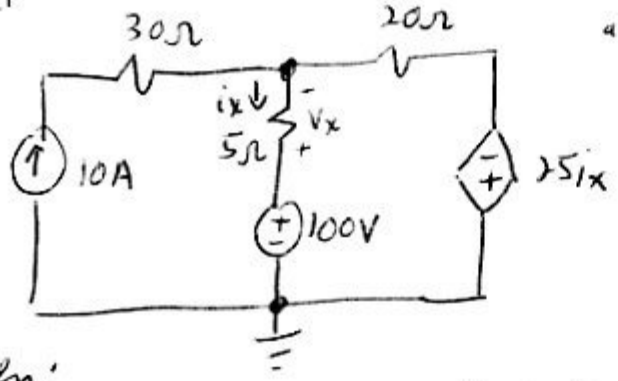
#4

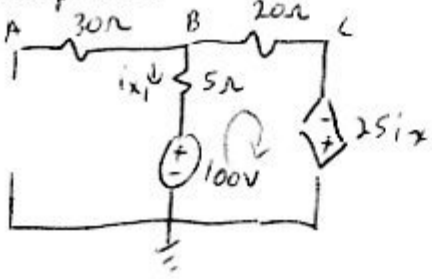



a) Find $i_x$ and $V_x$ by superposition.
(simpler prob: just find $i_x$)

b) Find power for the 5Ω resistor and 100V source; specify if absorbed or supplied.

Soln:

Keep 100V




Inspection Method: ← Ohm's Law

KVL: $-100 - 5i_{x_1} - 20i_{x_1} - 25i_{x_1} = 0$

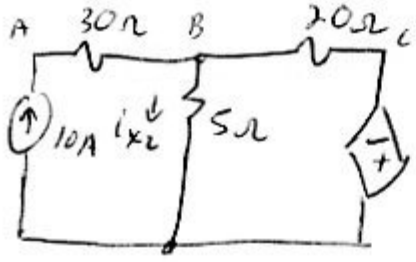
$i_{x_1} = \frac{100}{-50} = -2A \Rightarrow V_{x_1} = -i_x \times 5$ (Active notation)
$= +10V$

Or Node Method:

$\frac{V_B - 100}{5} + \frac{V_B - (-25i_{x_1})}{20} = 0$ (1) $\quad i_{x_1} = \frac{V_B - 100}{5}$ (2)

Solve: $V_B = 90V$, $i_{x_1} = -2A$

Keep 10A




Inspection Method: $V_B = 5i_{x_2}$

KCL at B: $-10A + i_{x_2} + \frac{5i_{x_2} - (-25i_{x_2})}{20\Omega} = 0$

$i_{x_2} = \frac{10}{2.5} = 4A \Rightarrow V_{x_2} = -i_x \times 5 = -20V$

Node Method:

Node B $-10A + \frac{V_B}{5} + \frac{V_B - (-25i_{x_2})}{20} = 0$ (1)

$i_{x_2} = V_B/5$ (2) Solve: $V_B = 20V$, $i_{x_2} = 4A$

Step 3 Add responses: $i_x = i_{x_1} + i_{x_2} = -2 + 4 = \boxed{2A}$

$V_x = V_{x_1} + V_{x_2} = 10 - 20 = \boxed{-10V}$

$P_5 = -V_x i_x$ (Active, not passive notation) ← or $i^2R$ or $V^2/R$
$= -(-10) \times 2 = +20W$ ∴ absorbed (as expected for R)

$P_{100} = 100V \times i_x$ (passive notation)
$= 100V \times 2A = +200W$ ∴ absorbed
(ie the 100V source is receiving energy → "being charged")