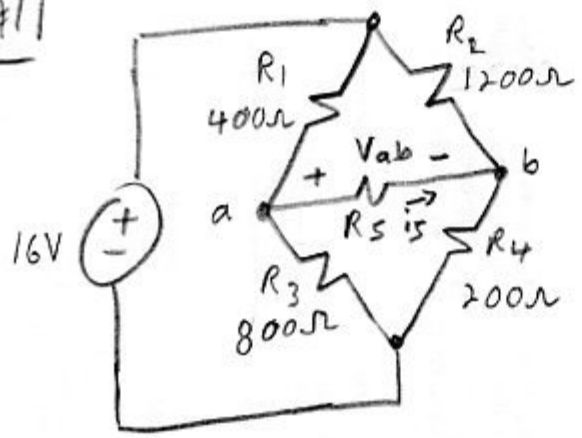
ENGG325 Midterm Fall 2008

#1



a) If $R_S = 400\Omega$, find V_{ab} and i_S.

b) If $R_S = 0$, find V_{ab} and i_S.

Soln

a) Place ground at bottom of circuit

Node a KCL: $\frac{V_a - 16}{400} + \frac{V_a - V_b}{400} + \frac{V_a}{800} = 0$ (1)

Node b KCL: $\frac{V_b - 16}{1200} + \frac{V_b - V_a}{400} + \frac{V_b}{200} = 0$ (2)

Solving:

(1) × 800: $2V_a - 32 + 2V_a - 2V_b + V_a = 0$

$5V_a - 2V_b = 32$ (3)

(2) × 1200: $V_b - 16 + 3V_b - 3V_a + 6V_b = 0$

$-3V_a + 10V_b = 16$ (5)

(3) × 5: $25V_a - 10V_b = 160$ (6)

(5) + (6): $22V_a = 176 \Rightarrow V_a = 8V$, $V_b = 4V$

$\therefore V_{ab} = V_a - V_b = \boxed{4V}$ $\quad i_S = \frac{V_{ab}}{400} = \boxed{10mA}$

(b) $400 // 1200 = 300\Omega$ $\quad 800 // 200 = 160\Omega$

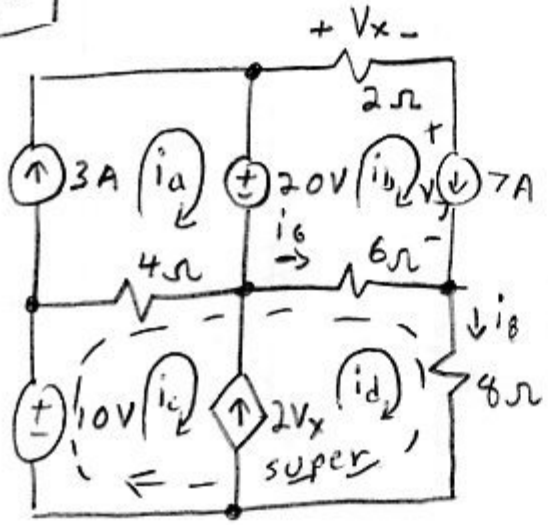
$\therefore V_a = V_b = 16V \times \frac{160}{160+300} = 5.57V \Rightarrow \boxed{V_{ab} = 0}$

R1 current: $i_1 = \frac{16 - 5.57}{400} = 26.09\ mA$

R3 current: $i_3 = \frac{5.57}{800} = 6.96\ mA$

$i_S = i_1 - i_3 = \boxed{19.13\ mA}$ (By KCL at point a)

#2



a) Find all mesh currents.

b) Find i_6 and i_8.

c) Find the power of the 10V source, indicating if it is absorbed or supplied.

d) Find power of 7A source ... absorbed / supplied.

Soln: lable mesh currents i_a, i_b, i_c, i_d, + supermesh

(a) $\boxed{i_a = 3A}$ (1) $\boxed{i_b = 7A}$ (2) ← currents on perimeter

supermesh: $-10 + 4(i_c - 3) + 6(i_d - 7) + 8 i_d = 0$ (3)

constraint: $2V_x = i_d - i_c$ (4)

controlling: $V_x = 2\Omega * i_b = 2 i_b$ (5)

(3) simplifies to $4 i_c + 14 i_d = 64$ (6)

(2) → (5): $V_x = 14V$ (7)

(7) → (4): $i_d = 28 + i_c$ (8)

(8) → (6): $4 i_c + 14 i_c = 64 - 392 \Rightarrow \boxed{i_c = -18.22A}$

$\boxed{i_d = 9.78A}$

(b) $i_6 = i_d - i_b = \boxed{2.78A}$ $i_8 = i_d = \boxed{9.78A}$

(c) Non-passive notation $P_{10} = -vi = -(10V)(i_c) = -10 \times -18.22$

$= +182.2W$ absorbed

(d) lable V_7 on circuit $V_7 = i_6 * 6\Omega + 20V - i_b * 2\Omega$

$= 16.67V + 20V - 14V = 22.67V$

passive notation: $P_7 = vi = V_7(7A) = 22.67 * 7 = +158.7W$ absorbed

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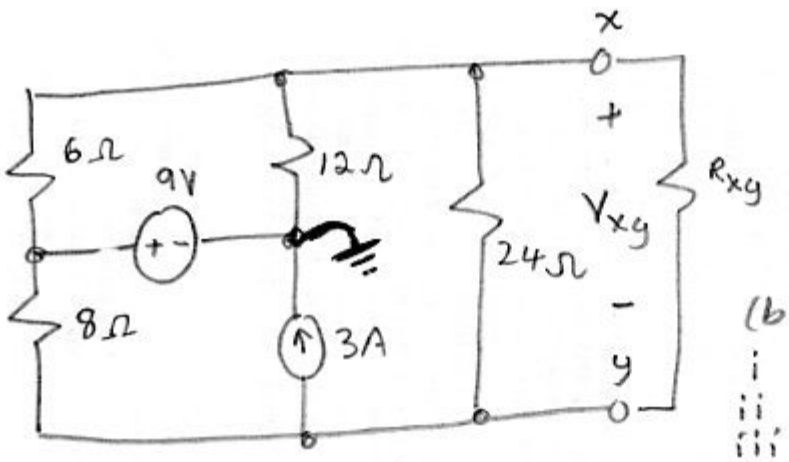
#3



(a) Find the Thevenin equivalent circuit left of terminals x & y.

(b) Find V_{xy} if
i $R_{xy} = 2\Omega$
ii 6Ω
iii 8Ω
iv 20Ω

Soln Place ground on negative terminal of 9V source

Step 1 Find $V_{oc} = V_x - V_y$ with $R_{xy} = \infty$ (open circuit)

Node x KCL: $\frac{V_x - 9}{6} + \frac{V_x}{12} + \frac{V_x - V_y}{24} = 0$ (1)

Node y KCL: $\frac{V_y - 9}{8} + 3 + \frac{V_y - V_x}{24} = 0$ (2)

(1) ×24: $4V_x - 36 + 2V_x + V_x - V_y = 0$

$7V_x - V_y = 36$ (3)

(2) ×24: $3V_y - 27 + 72 + V_y - V_x = 0$

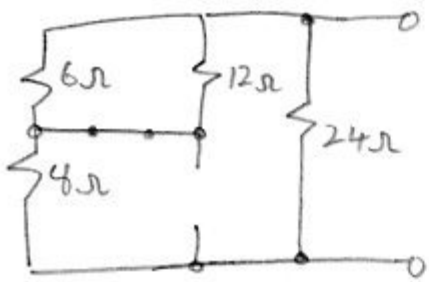
$-V_x + 4V_y = -45$ (4)

(3) × 4: $28V_x - 4V_y = 144$ (5)

(4) + (5): $27V_x = 99 \Rightarrow V_x = 3.667V$, $V_y = -10.333V$

$V_T = V_{oc} = V_x - V_y = \boxed{14V}$

Step 2 No dependent sources
∴ zero sources!

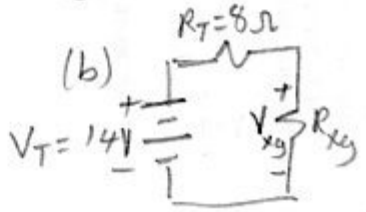


$R_T = [8\Omega + 6\Omega // 12\Omega] // 24\Omega$

$= (8 + 4) // 24$

$= \boxed{8\Omega}$

(b)



$V_{xy} = 14V \times \frac{R_{xy}}{R_{xy} + 8\Omega}$

$R_{xy} = 2\Omega \Rightarrow V_{xy} = \boxed{2.8V}$

$6\Omega \Rightarrow \boxed{6V}$

$8\Omega \Rightarrow \boxed{7V}$

$20\Omega \Rightarrow \boxed{10V}$

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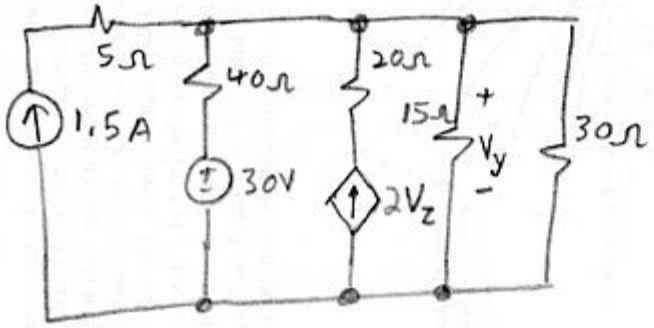
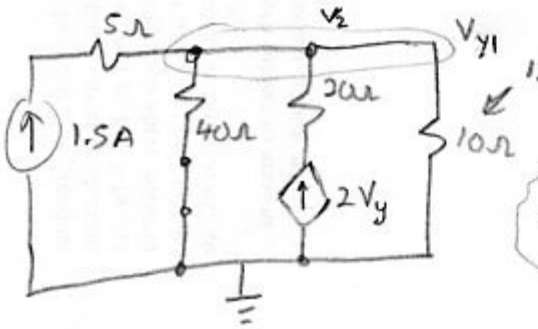
#4



a) Find V_2 using the principle of superposition.

b) Find power for each source indicating if it is supplied or absorbed.

Step 1 Keep 1.5A source!



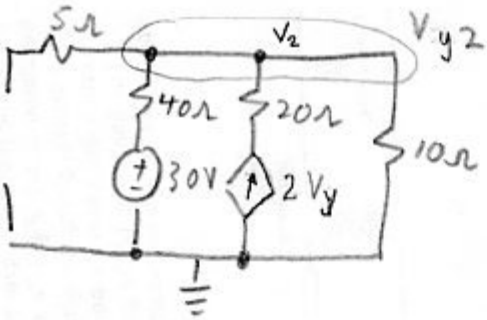
KCL at 2: $-1.5 + \frac{V_2}{40} - 2V_2 + \frac{V_2}{10} = 0$ (1)

(1) ×40: $-60 + V_2 - 80V_2 + 4V_2 = 0$

$V_{y1} = \frac{60}{-75} = -0.8V$

FYI our controlling eqn is $V_2 = V_y$

Step 2 Keep 30V source



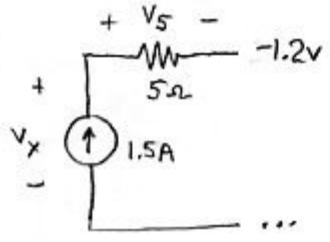
KCL at 2: $\frac{V_2 - 30}{40} - 2V_2 + \frac{V_2}{10} = 0$ (2)

(2) ×40: $V_2 - 30 - 80V_2 + 4V_2 = 0$

$V_{y2} = \frac{30}{-75} = -0.4V$

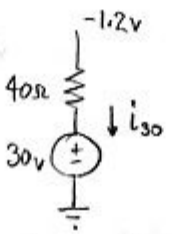
Step 3 $V_y = V_{y1} + V_{y2} = \boxed{-1.2V}$

(b)



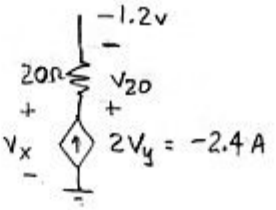
$V_x = -1.2v + V_5$
$= -1.2 + 1.5 \times 5$
$= 6.3v$

$P_{1.5} = -Vi = -6.3 \times 1.5$
$= -9.45\,W$ (supplied)



$i_{30} = \frac{-1.2 - 30}{40} = -0.78\,A$

$P_{30} = +vi = 30 \times -0.78$
$= -23.4\,W$ (supplied)



$V_x = -1.2v + V_{20}$
$= -1.2 + -2.4 \times 20$
$= -49.2v$

$P_x = -vi = -(-49.2) \times (-2.4)$
$= -118.08\,W$ (supplied)