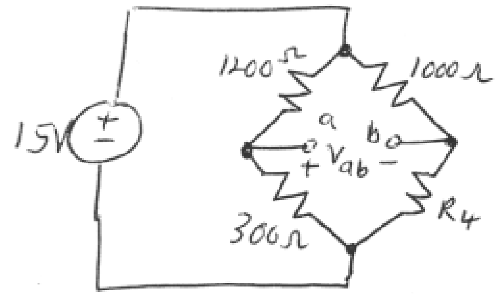
Solutions for ENGG325 Midterm Exam Oct 21, 2004

Question 1



(a) V_{ab} measured $= -2V$

Find R_4

(b) Now $R_5 = 200\Omega$ connected from a to b. Find power in R_5

Soln: (a) with no element between a and b, we can use voltage division:

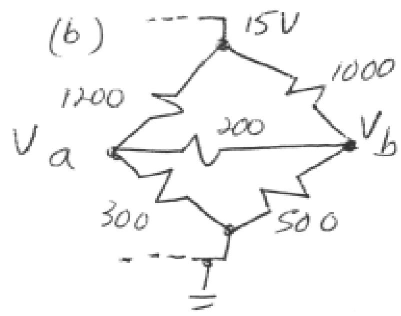
Call the bottom node 0V, then

$$V_a = \frac{300}{1500} \times 15V = 3V$$

$$V_{ab} = V_a - V_b \Rightarrow V_b = V_a - V_{ab} = 3V - (-2V) = 5V$$

$$\therefore V_b = \frac{R_4}{1000 + R_4} \times 15V = 5V \Rightarrow \boxed{R_4 = 500\Omega}$$

(b)



Say we use the node method:

Node a: $\frac{V_a}{300} + \frac{V_a - V_b}{200} + \frac{V_a - 15}{1200} = 0$

$\times 1200$: $4V_a + 6(V_a - V_b) + V_a = 15$

$\Rightarrow 11V_a - 6V_b = 15$ (1)

Node b: $\frac{V_b}{500} + \frac{V_b - V_a}{200} + \frac{V_b - 15}{1000} = 0$

$\times 1000$: $2V_b + 5(V_b - V_a) + V_b = 15$

$-5V_a + 8V_b = 15$ (2)

$\frac{4}{3} \times (1)$: $\frac{44}{3} V_a - 8V_b = 20$ (3)

(2) + (3): $\frac{29}{3} V_a = 35 \Rightarrow V_a = \underline{3.62V}$

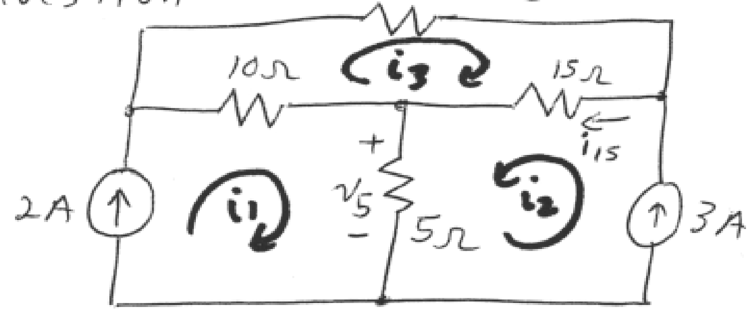
From (1) or (2) or (3) $V_b = \underline{4.14V}$

or could use $(V_{ab})^2$ ie $(-0.52V)^2$

$$P = \frac{V_{ba}^2}{R} = \frac{(0.52V)^2}{200} = 1.35 \times 10^{-3} = \boxed{1.35\,mW}$$

check $I^2 R = \left(\frac{0.52}{200}\right)^2 \times 200 = 1.35\,mW$

Question 2



Find v_5 and i_{15}

Soln: Lots of current sources, so mesh method is a good choice

Loop 1: $i_1 = 2A$

Loop 2: $i_2 = 3A$

$\therefore v_5 = iR$

$= (i_1 + i_2)R$

$= 5A \times 5\Omega = \boxed{25V}$

Loop 3: $25 i_3 + 15(i_2 + i_3) + 10(i_3 - i_1) = 0$

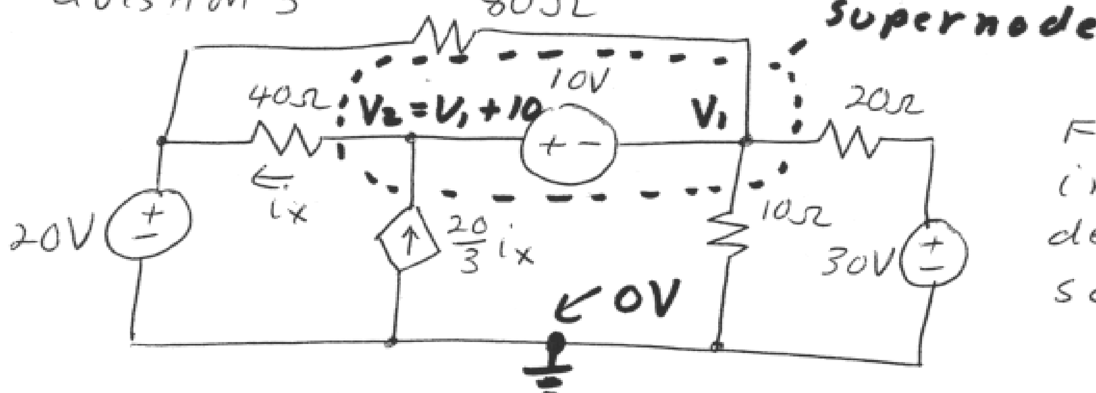
$25 i_3 + 15(3 + i_3) + 10(i_3 - 2) = 0$

$50 i_3 = -25$

$i_3 = -\frac{1}{2} A$

$\therefore i_{15} = i_2 + i_3 = \boxed{2.5A}$

Question 3



Find power in the dependent source

soln: With so many voltage sources, there is just one node equation, ie, for the super node:

$$\frac{V_2 - 20}{40} - \frac{20}{3} i_x + \frac{V_1 - 20}{80} + \frac{V_1}{10} + \frac{V_1 - 30}{20} = 0 \quad (1)$$

But $V_2 = V_1 + 10$ and $i_x = \frac{(V_1 + 10) - 20}{40}$

Substituting both expressions into (1) gives:

$$\frac{V_1 - 10}{40} + \frac{1}{6}(10 - V_1) + \frac{V_1 - 20}{80} + \frac{V_1}{10} + \frac{V_1 - 30}{20} = 0 \quad (2)$$

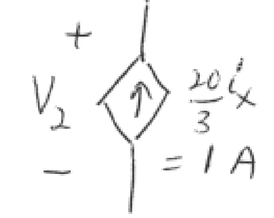
$240 \times (1)$: $6V_1 - 60 + 400 - 40V_1 + 3V_1 - 60 + 24V_1 + 12V_1 - 360 = 0$

or $5V_1 = 80 \Rightarrow \underline{V_1 = 16V}$

$\therefore \underline{V_2 = 26V}$

$\underline{i_x = \frac{26 - 20}{40} = \frac{6}{40} A}$

$\therefore$



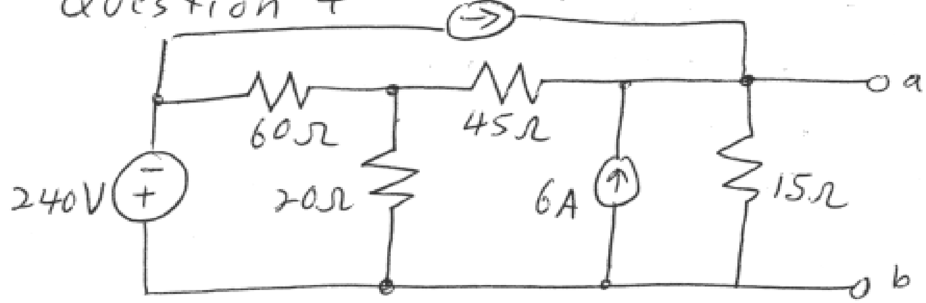
← This is not passive notation

$\therefore P = -vi$

$= -26 \times 1 = -26W$ ← supplying power

$\therefore$ 26W is being generated by the dependent source

Question 4

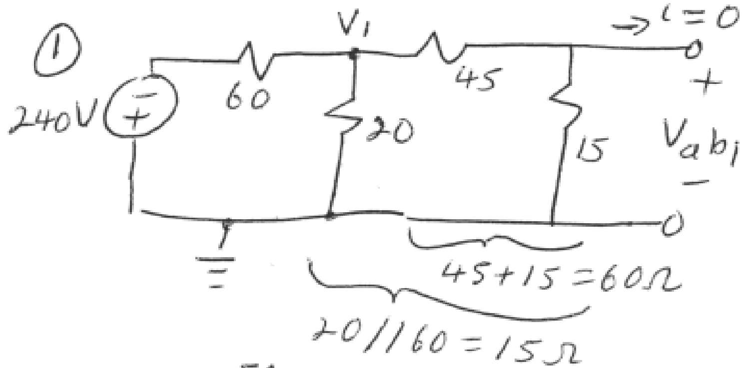


(a) Find V_{ab} by superposition

(b) Short a to b and Find I_{ab}

Soln (a) Apply one independent source at a time:

(1)



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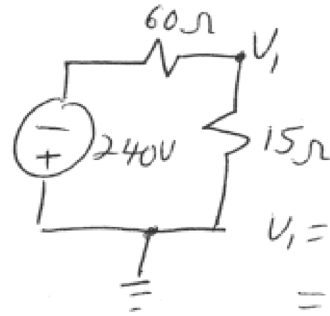
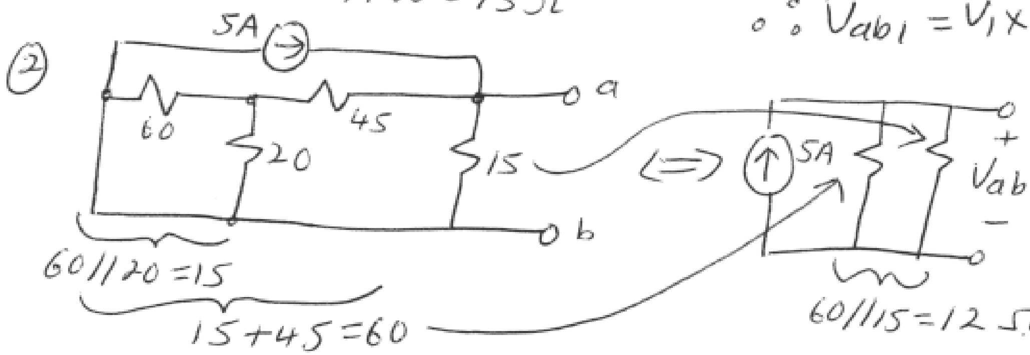


$V_1 = -240 \times \frac{15}{75}$

$= -48V$

$\therefore V_{ab_1} = V_1 \times \frac{15}{45+15} = \underline{\underline{-12V}}$

(2)



$V_{ab_2} = 5A \times 12\Omega$

$= \underline{\underline{60V}}$

(3)

Resistors combine same way as in step (2)

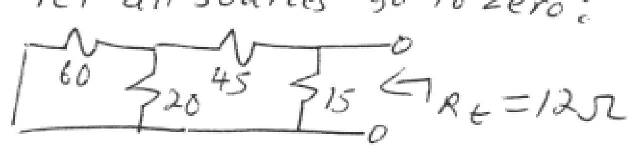
$\therefore V_{ab_3} = 6A \times 12\Omega = \underline{\underline{72V}}$

(4) $V_{ab} = V_{ab_1} + V_{ab_2} + V_{ab_3} = \underline{\underline{120V}}$

(b) Realizing that we have just found V_{oc} in part (a), to find I_{sc}, use $I_{sc} = \frac{V_{oc}}{R_t}$.

sc = short circuit
oc = open circuit

Since no dependent sources, let all sources go to zero:



$R_t = 12\Omega$

$\therefore I_{ab} = I_{sc} = \frac{120V}{12\Omega} = \underline{\underline{10A}}$