EE10
Fall 07
Midterm 1

10/22/2007

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Problem 1: 23

Problem 2: 25

Problem 3: 25

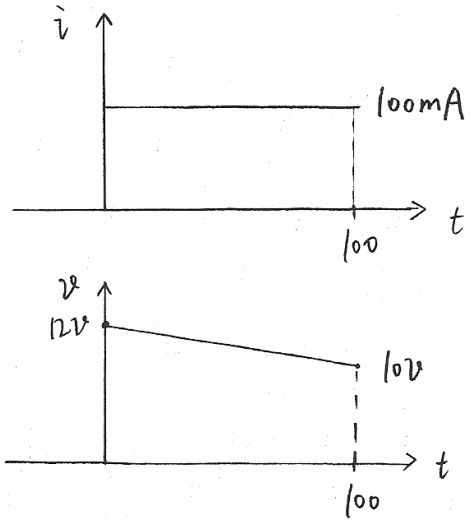
Problem 4: 25

Problem 5: 25

Total: 123

Prob. 1 (25%)

One GPS company declares that they invent a new type of GPS battery. On the user's menu they said that, this new type of battery could deliver ~~10mA~~ 100mA for 100 continuous hours. During that time, the voltage will drop from 12V to 10V. Assume the drop in voltage is linear with time. How much energy does the battery deliver in this 100 hour interval?



$p = \frac{dw}{dt} = iv$

$v = mt + b$ $\quad m = \frac{\text{rise}}{\text{run}} = \frac{-2}{100} = -0.02$

$12 = b$

$v = -0.02t + 12$ $\quad i = 100\text{mA} = 0.1\text{A}$

$p = \frac{dw}{dt} = iv = i(-0.02t + 12)$

$= 0.1(-0.02t + 12)$

$= -0.002t + 1.2$

$\frac{dw}{dt} = -0.002t + 1.2$

$dw = (-0.002t + 1.2)\,dt$

$w = \int_0^{w} dw = \int_0^{100} (-0.002t + 1.2)\,dt$

$= \left[\frac{-0.002t^2}{2} + 1.2t\right]_0^{100}$

$= \left(\frac{-0.002(100)^2}{2} + 1.2(100)\right) - 0$

$= -10 + 120 = 110\ \text{J}$

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the battery delivers 110J in this 100 hour interval.

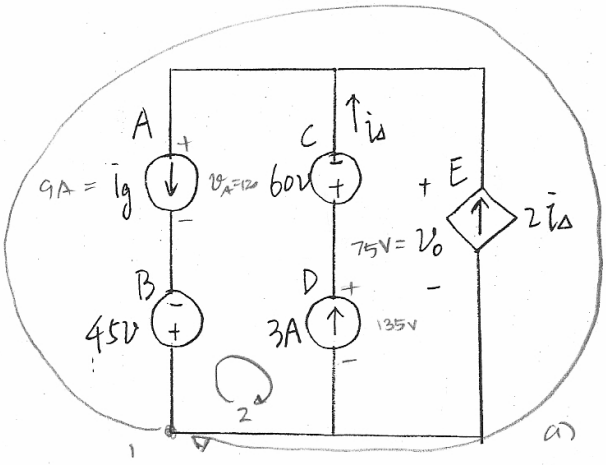
Convert in Seconds.

Prob. 2 (25%)

If $V_o = 75V$, $i_g = 9A$

a) Specify which power source is developing power, which power source is absorbing power.

b) Find the total power developed, and the total power absorbed. Verify the power developed equals the power absorbed.



Loop 1: $-45V + v_A - v_o = 0$

$v_A = v_o + 45$

$= 75 + 45 = 120V$

Loop 2: $-45V + v_A + 60V + v_D = 0$

$v_D = 45 - v_A - 60$

$= 45 - 120 - 60 = -135V$

$-i_g + i_\Delta + 2i_\Delta = 0$

$i_g = 3i_\Delta$

$i_\Delta = \frac{i_g}{3} = \frac{9}{3} = 3A$

a)

A - absorbing $P_A = 1080$

B - developing $P_B = 405$

C - absorbing $P_C = 180$

D - developing $P_D = 405$

E - developing $P_E = 450$

$P_{absorb} = 1080 + 180 = 1260W$

$P_{delivered} = 405 + 405 + 450 = 1260W$

$\therefore P_{absorb} = P_{developed}$

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Prob. 3 (25%)

Use KCL & KVL & Ohm's law to solve the following problem.

a) Find the power dissipated in each resistor.
b) Find the power delivered by the voltage source
c) Verify power delivered equals power dissipated.

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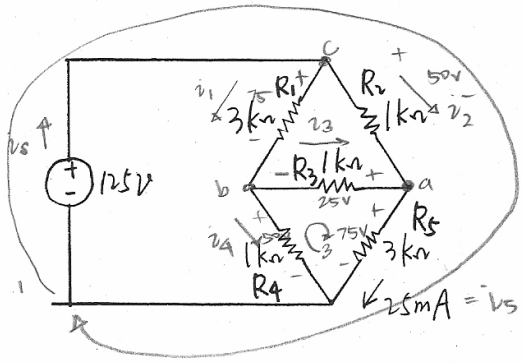


$P_5 \rightarrow v_5 = i_5 P_5 = (25\text{mA})(3\text{k}\Omega)$
$= 75\text{ V}$

Loop 1: $125 - v_2 - v_5 = 0$
$125 - v_2 - 75 = 0$
$v_2 = 50\text{ V}$

$v_2 = i_2 P_2$
$i_2 = \frac{v_2}{P_2} = \frac{50\text{V}}{1\text{k}\Omega}$
$= 50\text{mA}$

a) $i_2 + i_3 - i_5 = 0$
$i_3 = i_5 - i_2 = 25\text{mA} - 50\text{mA}$
$= -25\text{mA}$

$v_3 = i_3 P_3 = (-25\text{mA})(1\text{k}\Omega) = -25\text{V}$

Loop 3: $v_4 + v_3 - v_5 = 0$
$v_4 = v_5 - v_3 = 75 - 25\text{ V} = 50\text{ V}$

$v_4 = i_4 P_4 \Rightarrow i_4 = \frac{v_4}{P_4} = \frac{50\text{V}}{1\text{k}\Omega}$
$i_4 = 50\text{mA}$

b) $i_1 - i_3 - i_4 = 0$
$i_1 = i_3 + i_4 = -25\text{mA} + 50\text{mA} = 25\text{mA}$
$v_1 = i_1 P_1 = (25\text{mA})(3\text{k}\Omega) = 75\text{ V}$

c) $i_s - i_1 - i_2 = 0$
$i_s = i_1 + i_2 = 25 + 50 = 75\text{mA}$

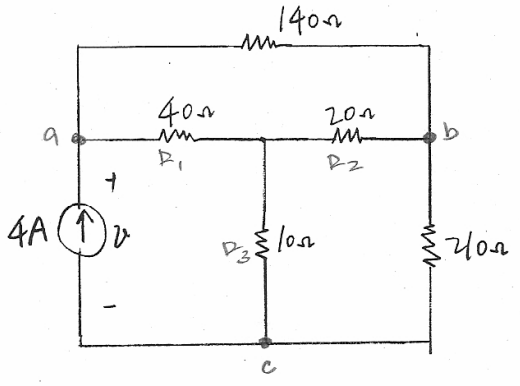
a) $P_1 = i_1 v_1 = (25\text{mA})(75\text{V}) = 1.875\text{ W}$
$P_2 = i_2 v_2 = (50\text{mA})(50\text{V}) = 2.5\text{ W}$
$P_3 = i_3 v_3 = (25\text{mA})(25\text{V}) = 0.625\text{W}$
$P_4 = i_4 v_4 = (50\text{mA})(50\text{V}) = 2.5\text{W}$
$P_5 = i_5 v_5 = (25\text{mA})(75\text{V}) = 1.875\text{W}$
Total power dissipated $= P_1 + P_2 + P_3 + P_4 + P_5$
$P_{dissipated} = 9.375\text{W}$

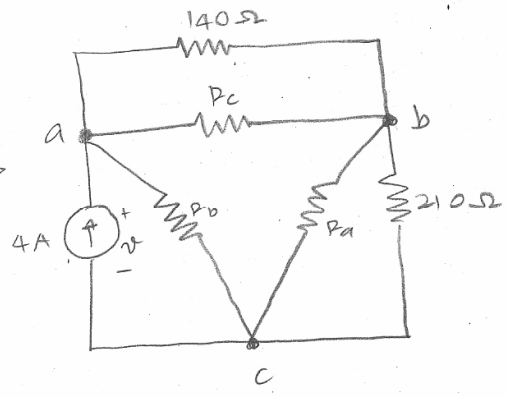
b) $P_s = i_s v_s = (75\text{mA})(125\text{V})$
$= 9.375\text{ W}$
$P_s = P_{delivered} = 9.375\text{W}$

c) power dissipated $= 9.375\text{W}$
power delivered $= 9.375\text{W}$
$\therefore$ power del = power dis

Prob. 4 (25%)

Use a Y to Δ transformation (around $40\Omega - 10\Omega - 20\Omega$) to find voltage v in the circuit.





$$R_a = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_1} = \frac{(40)(20) + (20)(10) + (40)(10)}{40} = \frac{1400}{40} = 35\Omega$$

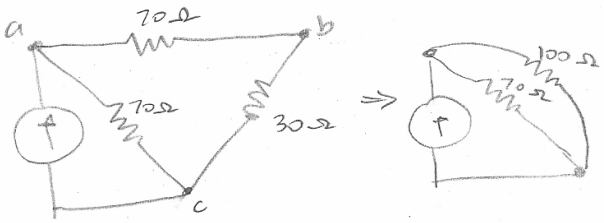
(800 + 200 + 400)

$$R_b = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_2} = \frac{1400}{20} = 70\Omega$$

$$R_c = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_3} = \frac{1400}{10} = 140\Omega$$

$$R_c \parallel R_{140\Omega} = \frac{(140)(140)}{140+140} = 70\Omega$$

$$R_a \parallel R_{210\Omega} = \frac{(35)(210)}{35+210} = 30\Omega$$



$$R_{70\Omega} + R_{30\Omega} = 100\Omega$$

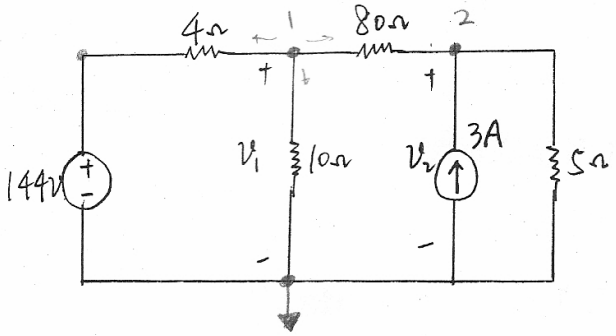
$$R_{100\Omega} \parallel R_{70\Omega} = \frac{(100)(70)}{100+70} = 41\Omega = R_{eq}$$

$$v_s = i_s R_{eq} = 4(41) = 164\ V$$

√5

Prob. 5 (25%) Bonus Problem

Use Node Voltage method to find v_1 and v_2



$v = iR \rightarrow i = \frac{v}{R}$

$$\frac{v_1 - 144}{4} + \frac{v_1}{10} + \frac{v_1 - v_2}{80} = 0 \rightarrow 0.25v_1 - 36 + 0.1v_1 + 0.0125v_1 - 0.0125v_2 = 0$$

$$\frac{v_2 - v_1}{80} - 3 + \frac{v_2}{5} = 0$$

$$* = 0.3625v_1 - 0.0125v_2 = 36$$

$$\frac{v_1 - 144}{4} + \frac{v_1}{10} - 3 + \frac{v_2}{5} = 0$$

$$= 0.25v_1 - 36 + 0.1v_1 - 3 + 0.2v_2 = 0$$

$$= 25v_1 - 3600 + 10v_1 - 300 + 20v_2 = 0$$

$$= 35v_1 - 3900 + 20v_2 = 0$$

$$v_2 = \frac{3900 - 35v_1}{20} = 195 - 1.75v_1$$

$$* \quad 0.3625v_1 - 0.0125v_2 = 36$$

$$0.3625v_1 - 0.0125(195 - 1.75v_1) = 36$$

$$0.3625v_1 - 2.4375 + 0.021875v_1 = 36$$

$$0.3844v_1 = 38.4375$$

$$v_1 = 99.99V \approx 100V$$

$$v_2 = \frac{3900 - 35v_1}{20} = \frac{3900 - 35(100)}{20} = 20V$$

$v_1 = 100V$

$v_2 = 20V$

75