ECE 110

Professors Brunet and Haken

February 13, 2006

HOUR EXAMINATION #1

Last Name (use capital letters): SOLUTIONS

First Name (use capital letters):____________________

Signature:______________________________________

Circle your section: AL1(1pm)-Brunet BL1(noon)-Haken

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD

Problem	Value	Score
1	**10**	
2	**20**	
3	**20**	
4	**10**	
5	**20**	
6	**20**	
Total	**100**	

A. Write or print clearly. Answer each problem on the exam itself. If you need extra paper, there is an extra sheet at the end of this exam. Clearly identify the problem number on any additional pages.

B. In order to receive partial or full credit, **you must show all your work**, e.g., your solution process, the equation(s) that you use, the values of the variables used in the equation(s), etc. You must also include the unit of measurement in each answer.

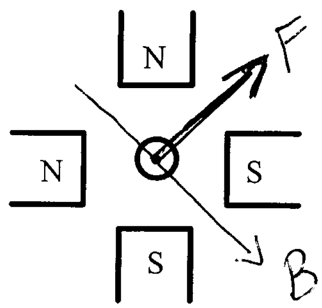
Students caught cheating on this exam will earn a grade of F for the entire course. Other penalties may include suspension and/or dismissal from the university.

Problem 1 *(10 points)*

For each situation below you must

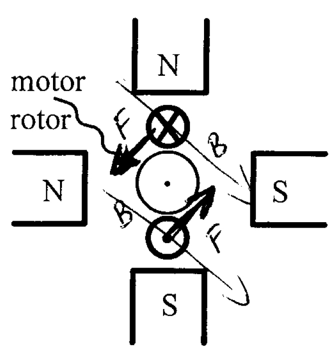
- draw and label the force F applied on each wire (**HINT**: draw the magnetic field B first).
- check the one most correct resulting initial motion.

i) *[5 pts.]* (No partial credit will be given for checking one answer without drawing F.)



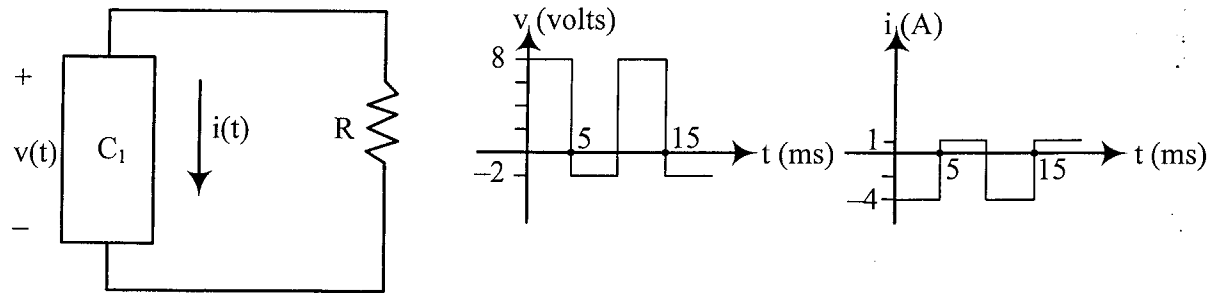
- [ ] The wire does not move.
- [ ] The wire moves up. (and right)
- [ ] The wire moves left.
- [x] None of the previous answers.

ii) *[5 pts.]* (No partial credit will be given for checking one answer without drawing F.)

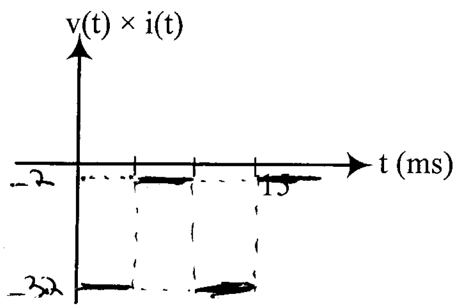


- [ ] The rotor does not move.
- [ ] The rotor moves clockwise.
- [ ] The rotor moves counterclockwise.

Problem 2 *(20 points)*



i) *[5 pts.]* Plot v(t) × i(t). Clearly label all points.

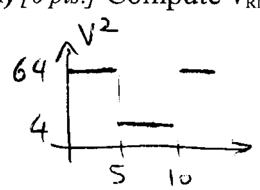


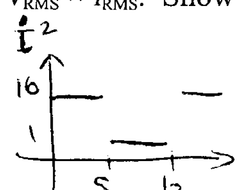
ii) *[5 pts.]* Compute A_1 = average (v(t) × i(t)). Show work.

$\frac{(-32)\times 5 + (-2)\times 5}{10} = -17$

A_1 = −17 W

iii) *[6 pts.]* Compute v_{RMS}, i_{RMS}, and $A_2 = v_{RMS} \times i_{RMS}$. Show work.





$V_{RMS} = \sqrt{\frac{64\times5 + 4\times5}{10}} = \sqrt{\frac{68}{2}}$

$I_{RMS} = \sqrt{\frac{16\times5 + 1\times5}{10}} = \sqrt{\frac{17}{2}}$

$\sqrt{\frac{68\times17}{4}} = \sqrt{289}$

v_{RMS} = 5.831 volts

i_{RMS} = 2.915 A

A_2 = 17 W.

iv) *[4 pts.]* Compare A_1 and A_2 (circle one) and give an explanation for the result obtained (i.e., the result was expected; why?).

- [x] $A_1 \neq A_2$
- [ ] $A_1 = A_2$

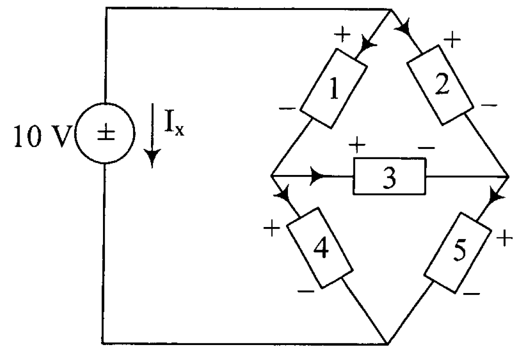
They have opposite signs

Explanation: A_1 = average (v . i) = $P_{average}$

$\frac{V}{i} = -R \Rightarrow P_{average} = -V_{RMS} \times i_{RMS}$

$\Rightarrow A_1 = -A_2$

Problem 3 *(20 points)*



$i_1 = -1$ A

$i_4 = 2$ A

$i_5 = 3$ A

$v_2 = -4$ V

$v_3 = 3$ V

i) *[4 pts.]* How many nodes in this circuit?

4

ii) *[6 pts.]* How many independent KCL equations are there for this circuit? Write all the independent KCL equations.

4 - 1 = 3 indep. equations

$I_x + i_1 + i_2 = 0$

$i_1 = i_3 + i_4$

$i_2 + i_3 = i_5$

iii) *[6 pts.]* Write all the independent KVL equations. Use loops that involve the fewest number of voltage drops.

$10 = V_1 + V_4$

$V_2 = V_1 + V_3$

$V_4 = V_3 + V_5$.

iv) *[4 pts.]* Solve for I_x and v_4.

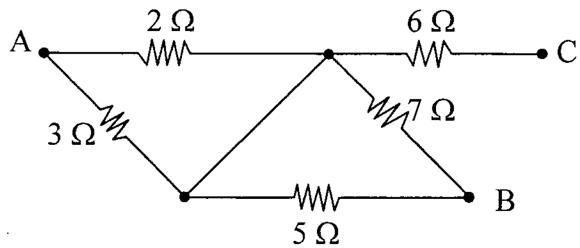
using (ii) ⇒ $I_x = -i_4 - i_5$
$= -2 - 3$

I_x = −5 A.

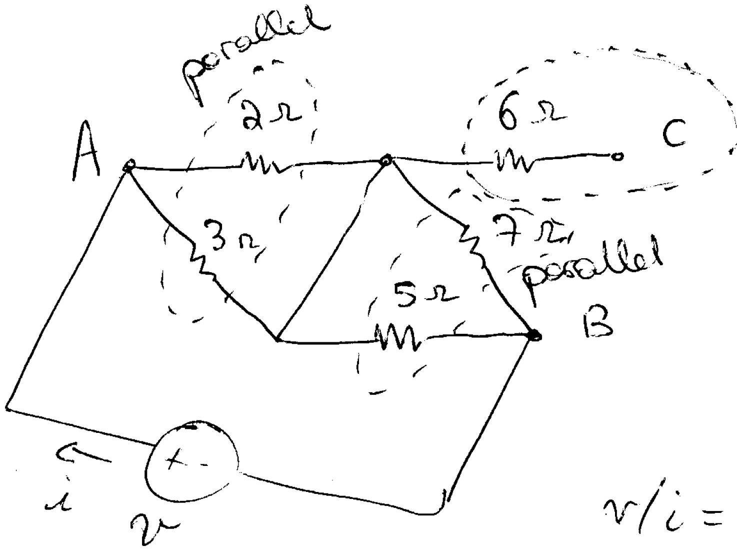
using (iii) ⇒ $V_4 = 10 + V_3 - V_2$
$= 10 + 3 - (-4)$

v_4 = 17 volts

Problem 4 *(10 points)*

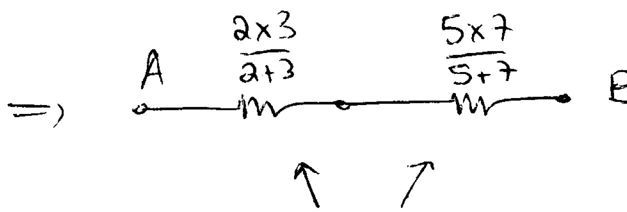


Find R_{EQ} between A and B. Show all of your work.

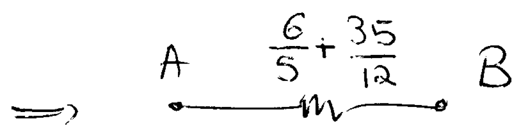


irrelevant (no current there ever).

v/i = Req between A & B.



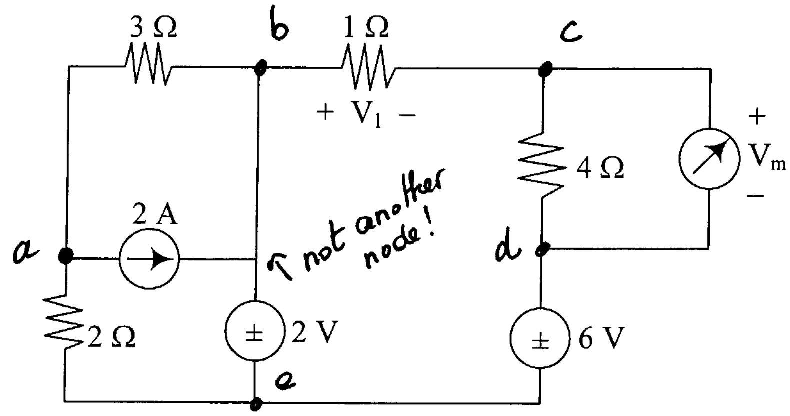
in series now.



$$\Rightarrow R_{eq} = \frac{6}{5} + \frac{35}{12} = \frac{72+175}{5\times12} = \frac{247}{60}$$

$R_{EQ} = \frac{247}{60}\,\Omega = 4.117\,\Omega$

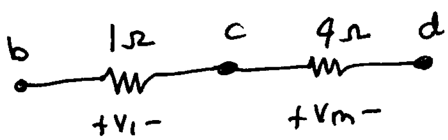
Problem 5 *(20 points)*



i) *[5 pts.]* How many nodes does the circuit above contain? Label all of them on the circuit.

number of nodes: 5

ii) *[10 pts.]* Use the voltage divider rule to compute the voltage V_m measured by the voltmeter. You must first draw below the portion of the circuit (i.e., a set of resistances only) that is used in your computation to apply VDR. Label all nodes using the notations you set in part **i)**.



$V_{bd} = V_{be} + V_{ed} = +2 - 6 = -4$

$V_m = V_{cd} = \frac{4}{1+4} V_{bd}$ (VDR) $\Rightarrow V_m = -16/5$ volts.

$V_m =$ $-16/5 = -3.2$ volts

iii) *[5 pts.]* Deduce V_1 using KVL (write the KVL equation first).

$V_1 + V_m = V_{bd}$ (KVL equation)

$V_1 - 16/5 = -4$

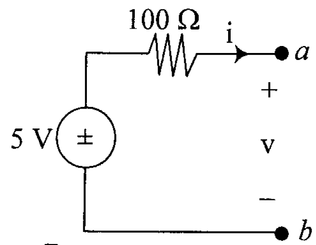
$\Rightarrow V_1 = -4 + 16/5$

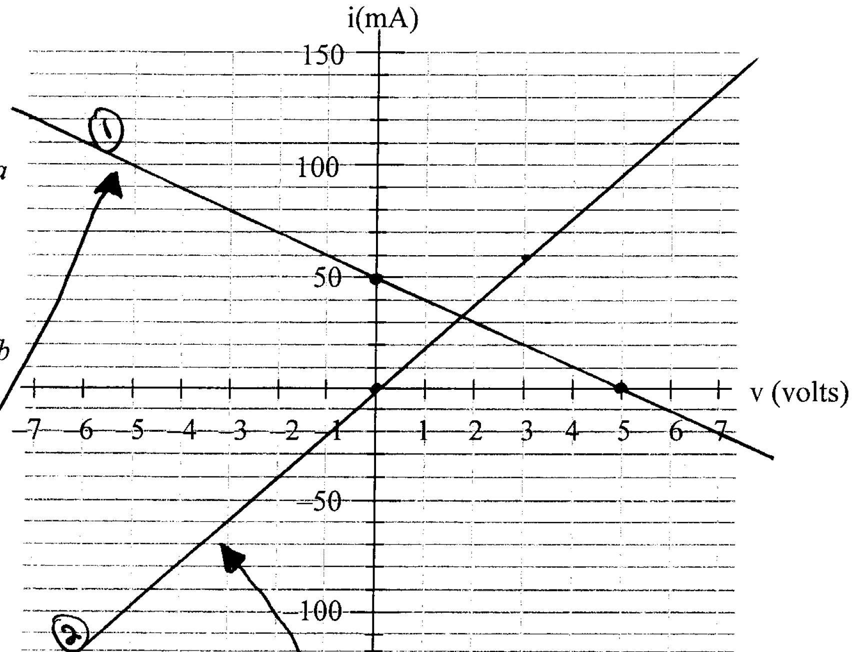
$= -4/5$

$V_1 =$ $-4/5 = -0.8$ volts

Problem 6 *(20 points)*

i) *[10 pts.]* Draw the I-V characteristic for this circuit.

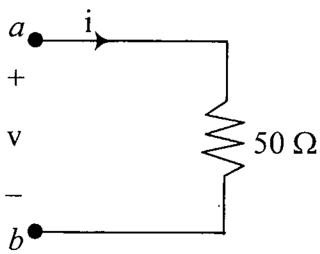




$i = \frac{5-v}{100}$

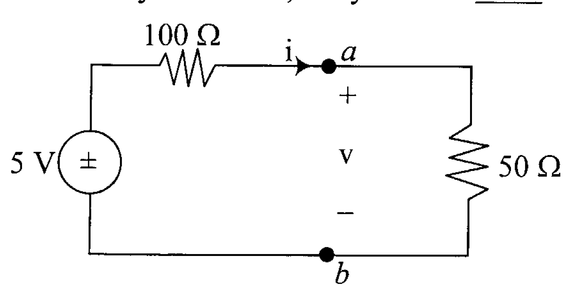
① $i = (50 - 10v)$ mA

ii) *[6 pts.]* Draw the I-V characteristic for this circuit.



$i = \frac{v}{50} = 20v$ mA ②

iii) *[4 pts.]* Solve for (i, v) when the two circuits are connected at *a* and *b*. Use any method of your choice, but you must <u>show</u> all your work or reasoning.



<u>different ways</u> of finding it:

- solve equations ① & ②
- graphical solution (intersection of ① and ②)
- solve the connected circuit. 100 & 50 are in series:

$$\begin{cases} i = \frac{5}{100+50} = \frac{5}{150} = 1/30 \text{ A} \\ v = 50 \times i = 50 \times 1/30 = 5/3 \text{ volt} \end{cases}$$

i = 1/30 A

v = 5/3 volts