ECE 110 **September 22, 2008**
Professors Brunet and Loui

HOUR EXAMINATION #1

1) Write your official:

Last Name (use capital letters):_____
First Name (use capital letters):_____
NetId & UIN:_____

2) Write your name and section at the back of the test.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD

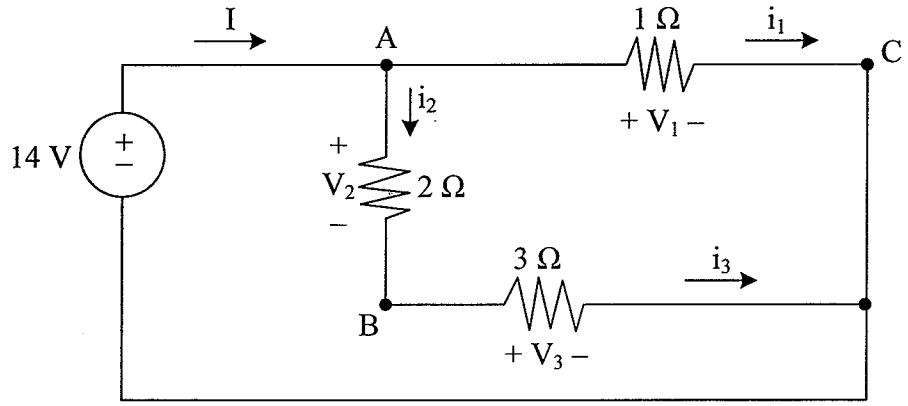
Make sure to write your name AGAIN at the top of every page of your exam.

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 *(40 points)*



a) *[6 pts.]* Write two KVL equations (use only <u>voltage</u> parameters). **Clearly indicate on the circuit which loop you are using.**

① ..... ② .....

b) *[6 pts.]* Write two KCL equations (use only <u>current</u> parameters). **Clearly indicate which node you are using.**

③ ..... ④ .....

c) *[6 pts.]* Write three Ohm Law equations.

⑤ ..... ⑥ ..... ⑦ .....

d) *[6 pts.]* Using equations above, solve the circuit. **Clearly show <u>all</u> steps you are using.**

(write answers on next page)

Problem 1 *(continued)*

$i_1 =$ $i_2 =$ $i_3 =$

$V_1 =$ $V_2 =$ $V_3 =$

$I =$

e) *[8 pts.]* Compute the SRS power for each component. **Show work.**

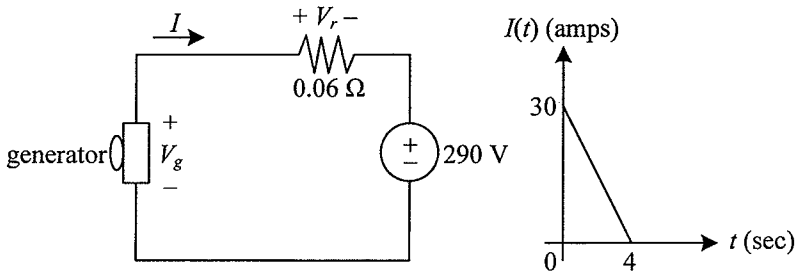
P (14 V) = P (2 Ω) =

P (1 Ω) = P (3 Ω) =

f) *[8 pts.]* Compute i_3 using the Current Divider Rule. **Clearly show work** (showing a formula is not enough — explain what you do).

$i_3 =$

Problem 2 *(20 points)* The kinetic energy of a Toyota Prius car is 53 kilojoules (kJ) when it travels at 20 miles per hour (mph). The car's regenerative braking system has a generator that converts the kinetic energy into electricity, which recharges the battery. We model the battery as a 290 V ideal voltage source and a 0.06 Ω resistor. Starting from a speed of 20 mph, the brakes are applied at time $t = 0$, and the current $I(t)$ from the generator decreases linearly from 30 A to 0 A at time $t = 4$ seconds (sec).



a) *[2 pts.]* Write a KVL equation that relates V_r and V_g.

b) *[4 pts.]* Determine the value of V_g when I reaches 0. **Explain your reasoning.**

$V_g =$ ____

c) *[8 pts.]* Determine the average SRS power P_{avg} for the 290 V voltage source between 0 and 4 seconds. **Show your work.**

$P_{avg} =$ ____

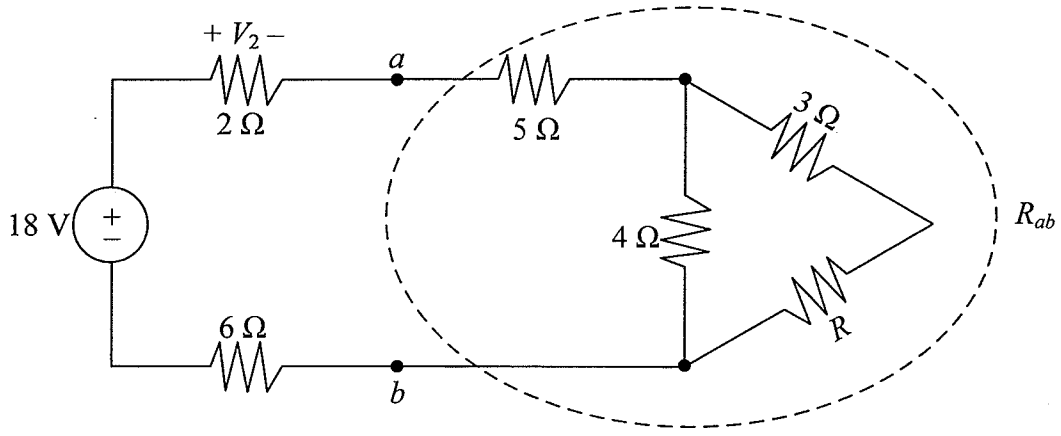
d) *[6 pts.]* Determine the total amount of energy returned to the voltage source and the efficiency of the regenerating system in this case.

Energy = ____

Efficiency = ____

Problem 3 *(20 points)*

a) *[10 pts.]* Show that the equivalent resistance R_{ab} between node a and node b is $\frac{9R+47}{R+7}\,\Omega$. **Explain your reasoning** using diagrams, formulas, **and words**.

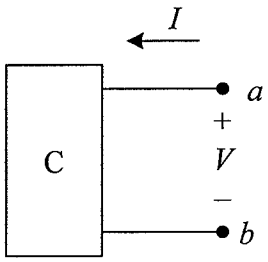


b) *[5 pts.]* Using part a), explain why it is **impossible** to choose R so that $R_{ab} < 6\ \Omega$.

c) *[5 pts.]* Using the Voltage Divider Rule, determine the value of V_2 when $R_{ab} = 7\ \Omega$.

$V_2 =$ ____

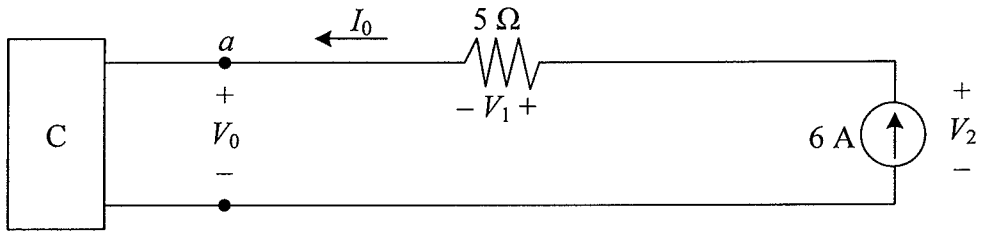
Problem 4 *(20 points)* The component C below has the I-V characteristic shown, with an unknown constant s. The units are amps and volts.



$I = s\,V - 4.8$

a) *[5 pts.]* Can C be a single resistor (with no other components)? Answer *yes* or *no* or *insufficient information*, and **justify your answer**.

b) When C is connected to the resistor and ideal current source shown below, the operating voltage V_0 is 9 V.



(i) *[5 pts.]* Determine the value of s (in amps/volts). **Show work.**

$s =$ ____

(ii) *[6 pts.]* Determine the values of V_1 and V_2. **Show work.**

$V_1 =$ ____

$V_2 =$ ____

(iii) *[4 pts.]* Does the 6 A current source generate or dissipate electrical power? **Justify your answer**. [HINT: $V_2 > 0$]