EECS70A Spring 2008 Midterm Exam #1

4/22/2008 11:00 to 12:20 pm

Professor Peter Burke

Name:________________________

ID no.:________________________

| 1 | 2 | 3 | 4 | 5 | 5 | Total |
|---|---|---|---|---|---|---|
| /10 | /10 | /20 | /20 | /20 | /20 | /100 |

# DO NOT BEGIN THE EXAM UNTIL YOU ARE TOLD TO DO SO.

**PROBLEM ONE: (10 points)**

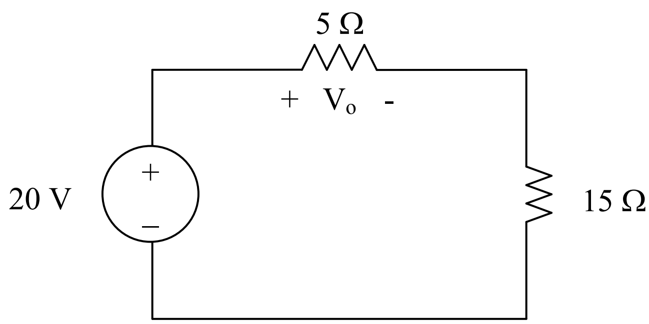
A battery may be rated in ampere-hours (Ah). A lead-acid battery is rated at 100 Ah.

a) What is the miximum current it can supply for 50 h?

b) How many days will it last if it is discharged at 1 mA?

**PROBLEM TWO(10 points):**

Calculate $V_o$ in the circuit below.

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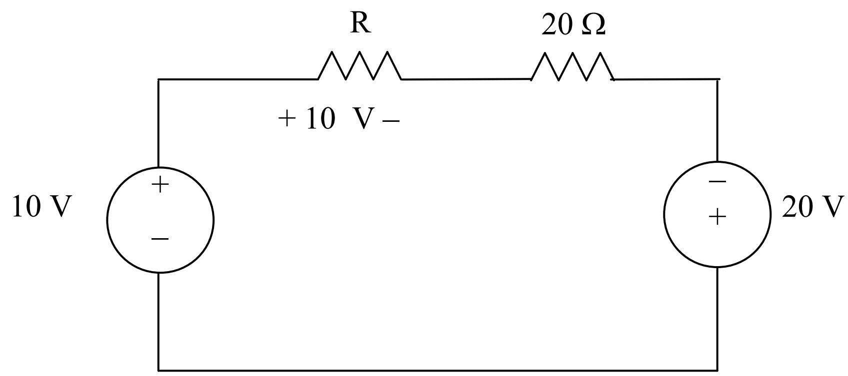
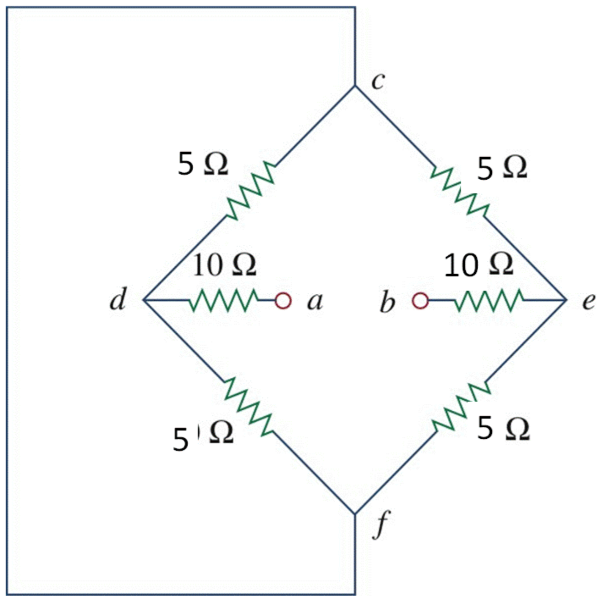
**PROBLEM THREE(20 points):**

Find R for the circuit below.



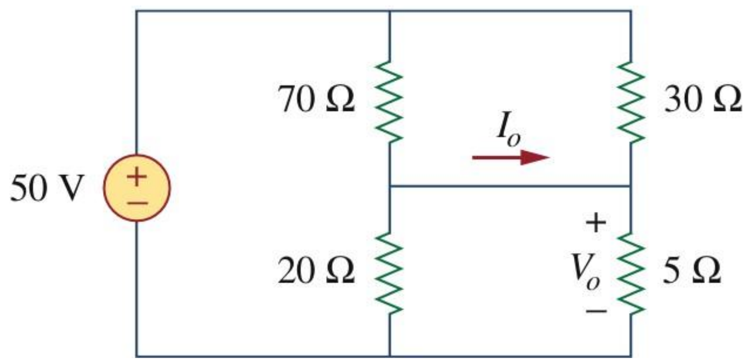
**PROBLEM FOUR(20 points):**

Find the equivalent resistance $R_{ab}$ in the circuit below.



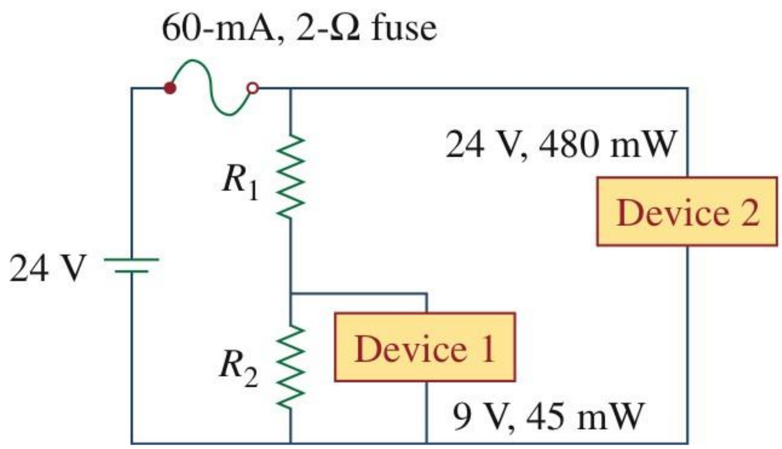
**PROBLEM FIVE (20 points):**

Calculate $V_o$ and $I_o$ in the circuit below.



**PROBLEM SIX(20 points):**

Two delicate devices are rated as shown in the figure below. Find the values of the resistors $R_1$ and $R_2$ needed to power the devices using a 24-V battery.



EECS70A / CSE 70A Network Analysis I
Prof. Peter Burke

Midterm I solution

Grading criteria for all questions: no credits for answers without units and - 5pts for each wrong unit.

Problem 1:

(a) $i = \frac{100\text{A} \cdot \text{h}}{50} = \underline{2\text{ A}}$

(b) $t = \frac{100\text{Ah}}{0.001\text{A}} = \frac{100{,}000\text{h}}{24\text{h / day}} = \underline{4{,}167\text{ days}}$

Grading criteria: 3pts for each correct charge and time equation
4pts for each wrong unit conversion with correct steps

Problem 2:

Using voltage division,

$$V_0 = \frac{5\Omega}{(15+5)\Omega}(20V) = 5V$$

Alternatively,

$$I_0 = \frac{20V}{20\Omega} = 1A \quad V_0 = 1A \cdot 5\Omega = 5V$$

Grading criteria: 2pts for only Ohm's Law
5pts for correct voltage division equation or equation for current $I_0$
7.5pts for correct answer with wrong sign

Problem 3:

Applying KVL,

$$-10 + 10 + 20I - 20 = 0, \qquad I = 1A$$

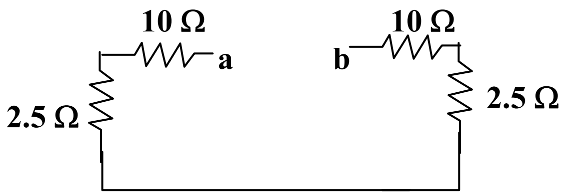
$$R = \frac{V}{I} = \frac{10}{1} = 10\Omega$$

Grading criteria: 2pts for only Ohm's law
5pts for only correct KVL with wrong current I
10pts for KVL equation with correct current I
15pts for correct current I with wrong resistance R

Problem 4:

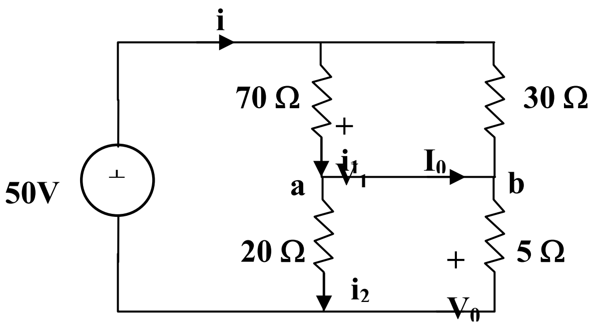
$5\|5 = 2.5\Omega \qquad 5\|5 = 2.5\Omega$

$R_{ab} = 10 + 2.5 + 2.5 + 10 = \underline{\mathbf{25\ \Omega}}$




Grading criteria: 3pts for any correct parallel and series calculations or Delta,Y conversion
5pts for only showing both 5Ω//5Ω configurations
7pts for only showing correct rearrangement of resistances
10pts for wrong final answer with correct steps

Problem 5:




Combining the versions in parallel,

$$70 \| 30 = \frac{70x30}{100} = 21\Omega \quad , 20 \| 5 = \frac{20x5}{25} = 4\ \Omega$$

$$i = \frac{50}{21+4} = 2\ A$$

$v_i = 21i = 42$ V, $v_0 = 4i = 8$ V

$$i_1 = \frac{v_1}{70} = 0.6\ A,\ i_2 = \frac{v_2}{20} = 0.4\ A$$

At node a, KCL must be satisfied

$i_1 = i_2 + I_0$ $\quad$ $0.6 = 0.4 + I_0$ $\quad$ $I_0 = 0.2$ A

Hence $v_0 =$ **8 V** and $I_0 =$ **0.2A**

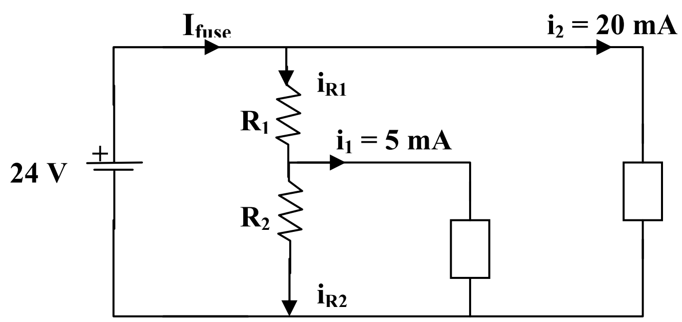
Grading criteria: 5pts for only correct KCL, KVL equation or correct simplification
7pts for wrong $I_0$ with correct $i_1$ and $i_2$ using correct KCL equation
7pts for wrong $V_0$ with correct KVL equation
10pts for only correct $V_0$ with correct simplification steps

Problem 6:

The voltage across the fuse should be negligible when compared with 24 V.

$$I_1 = \frac{p_1}{V_1} = \frac{45mW}{9V} = 5mA$$

$$I_2 = \frac{p_2}{V_2} = \frac{480mW}{24} = 20mA$$



Let $R_3$ represent the resistance of the first device.

$$R_3 = 9/0.005 = 1{,}800\ \Omega$$

The fuse condition (60 mA, 2 Ω) is not a fixed condition, but is the maximum condition. The voltage across $R_3$ must equal 9 volts. Since the circuit is powered by a battery we could choose the value of $R_2$ which draws the least current, **$R_2 = \infty$**. Thus we can calculate the value of $R_1$ that give 9 volts across $R_3$.

$$9 = (1800/(R_1 + 1800))24 \text{ or } R_1 = (24/9)1800 - 1800 = \mathbf{3{,}000\Omega}$$

This value of $R_1$ means that we only have a total of 25 mA flowing out of the battery through the fuse.

Grading criteria: 5pts for only correct power equation

7pts for each answer of $R_1=375\ \Omega$, $R_2=257\ \Omega$ with correct $i_1$

10pts for correct $i_1$(device 1) with correct power equation

12pts for correct $i_1$ and correct $i_{R1}=40mA$ and $i_{R2}=35mA$

15pts for correct $i_1$ and one correct $R_1=3\ K\ \Omega$ or $R_2=\infty\Omega$