Solution

National Taiwan Normal University
Department of Computer Science and Information Engineering

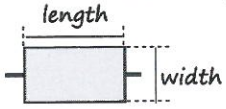
CSU0007 - Basic Electronics

Homework 1

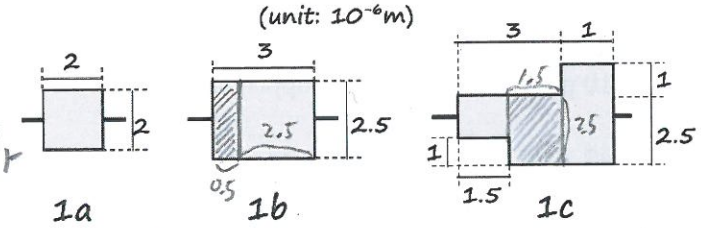
(Five questions. 100 points total. Due on 10PM, Tuesday, 3/17/2020. Submit your answer via Moodle)
Clearly state <u>each step</u> of your calculation to receive full score.

1. (15 points) Let r be the resistance of a linear planar resistor with width=length=5×10^{-6}m and thickness of 10^{-6}m. What are the resistance of the following resistors of the same material (and of the same thickness)?
   1a. (5 points)
   1b. (5 points)
   1c. (5 points) (Hint: study Example 2.21 in the textbook)

$R=\rho\frac{l}{a}$



(unit: 10^{-6}m)



1a 1b 1c

1a. r

1b. 串聯 $\frac{1}{5}r+r=\frac{6}{5}r$

1c. 三個串聯 $1.5r+\frac{1.5}{2.5}r+\frac{1}{3.5}r=\frac{167}{90}r$

2. (20 points) Mr. Wang was learning to make some yogurt. In the making process, it is critical to make sure the temperature of the yogurt stays between 32.2°C and 48.9°C. He used an Arduino Uno (<u>https://store.arduino.cc/usa/arduino-uno-rev3</u>) to monitor the temperature. His Arduino Uno consumes 250mW of power in average.
   2a. (10 points) For how long can a full 5V, 500mAh battery sustain this Arduino Uno? (Hint: study the related example in note1 for lecture on 3/2/2020)
   2b. (10 points) To keep powering the Arduino Uno for a whole week, what is the minimum required battery capacity (in terms of mAh)?

2a. $5\times500\times10^{-3}=2.5$ wh

$\frac{2.5}{250\times10^{-3}}=10$ hours ※

2b. power demand
$=24\times7\times250=42000$ mWh
for a 5V battery, the capacity should be at least $42000/5=8400$ mAh ※

3. (20 points) Mrs. Wang brought an LED light for her night reading. Within the light there is a resistor with resistance R = 1kΩ. The resistor can dissipate a maximum of 0.4W of power, and it will overheat if the power dissipation exceeds 0.4W.
   3a. (10 points) Mrs. Wang used a battery rated at 7.2V to power the LED light. Would that overheat the light? (Hint: study Example 1.16 in the textbook)
   3b. (10 points) Mr. Wang Jr. plugged the light into a 110V wall plug. Would that overhead the light?

3a. $P=VI=V\left(\frac{V}{R}\right)=\frac{V^2}{R}$

$=\frac{7.2^2}{10^3}=51.84$ mW <0.4 W $\Rightarrow$ safe

3b. $P=\frac{110^2}{10^3}=12.1$ W >0.4 W $\Rightarrow$ that would overheat the light!

4. (30 points) In the following, use KCL and KVL to determine the branch current and branch voltage with respect to each lumped element.

4a. (10 points) In Figure 4a, suppose i_1=5A, i_2=2A, i_5=4A, i_8=1A. Determine i_3, i_4, i_6, and i_7.

using KCL:

node A $i_1 + i_4 + i_5 = 0 \Rightarrow i_4 = -9\,A$

node B $i_7 - i_5 - i_8 = 0 \Rightarrow i_7 = 5\,A$

node C $i_6 + i_8 - i_2 = 0 \Rightarrow i_6 = 1\,A$

node D $-i_3 + i_2 - i_1 = 0 \Rightarrow i_3 = -3\,A$

可用其它 node 驗算，例如 node E $\Rightarrow i_3 - i_4 - i_7 - i_6 = 0$

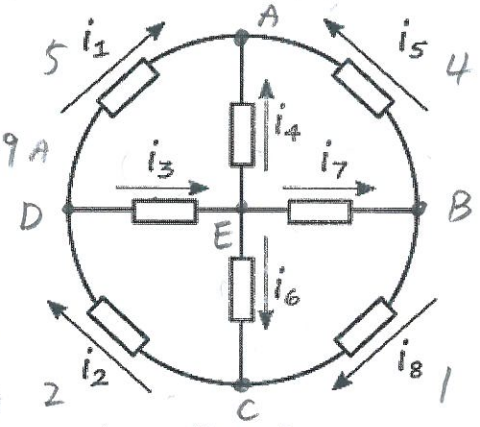


Figure 4a

4b. (10 points) In Figure 4b, suppose v_1=6V, v_2=3V, v_6=2V, v_8=1V. Determine v_3, v_4, v_5, and v_7.

using KVL:

loop l_1: $V_2 + V_1 + V_5 - V_8 = 0 \Rightarrow V_5 = -8V$

loop l_2: $V_2 - V_3 + V_6 = 0 \Rightarrow V_3 = 5V$

loop l_3: $V_1 - V_4 + V_3 = 0 \Rightarrow V_4 = 11V$

loop l_4: $V_4 + V_5 - V_7 = 0 \Rightarrow V_7 = 3V$

loop l_5 驗算 $V_6 + V_8 - V_7 = 0$

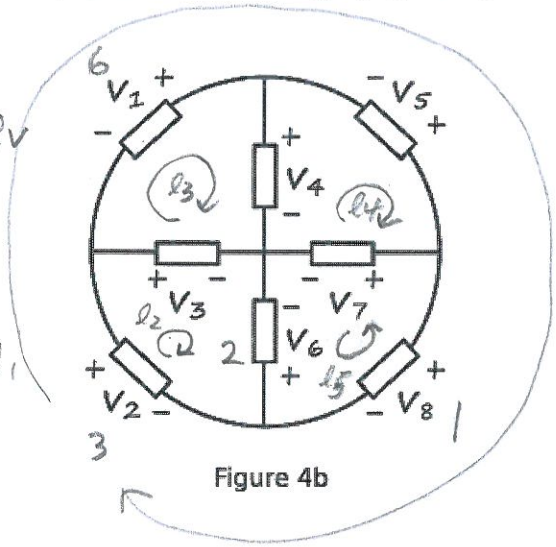


Figure 4b

4c. (10 points) In Figure 4c, suppose i_1=3A and R_2=15Ω. Determine v_1, v_2, R_1, and i_2.

using KVL for loop l_1, we see

$V_1 = V_2$

using KVL for loop l_2, we see

$V_1 = 30\,V$, thus $V_2 = 30\,V$

using Ohm's law,

$$R_1 = \frac{V_1}{i_1} = \frac{30}{3} = 10\,\Omega$$

$$i_2 = \frac{V_2}{R_2} = \frac{30}{15} = 2\,\Omega$$

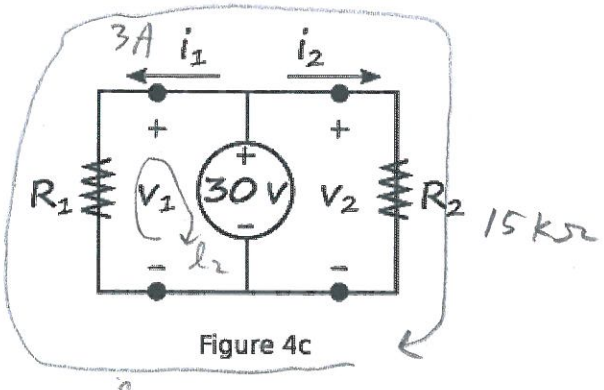


Figure 4c

5. (15 points) Consider the following voltage dividers.

5a. (10 points) Suppose R_1=7kΩ and R_2=8kΩ. What is the branch voltage across resistor R_2?

$$V_2 = \frac{R_2}{R_1+R_2} \times 5V = \frac{8}{3} V$$

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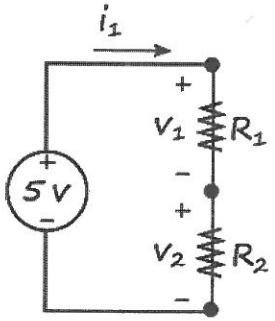

5b. (5 points) Suppose R_1=10kΩ. If we want to have a branch voltage of 3V across resistor R_2. What should be the resistance of R_2?

$$3 = \frac{R_2}{R_1+R_2} \times 5$$

$$= \frac{R_2}{10+R_2} \times 5$$

$$\Rightarrow 30 + 3R_2 = 5R_2$$

$$\Rightarrow R_2 = 15\ k\Omega$$

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