EEE 31 second semester AY2013-2014 : Problem Set 01

1 Problem 1

In experiments, readings of voltages and currents usually suffer from mesurement errors. Given the table of values for voltage and current for a resistive device A, what is the "best" estimate for the resistance of device A.

voltage (V)	current (mA)
1	0.80
2	1.76
3	2.44
4	3.65
5	4.28
6	4.55
7	5.55
8	7.23
9	7.29
10	8.45

Table 1:

2 Problem 2

Shown in Figure 1 are the plots for voltage and current for device B. Plot the power absorbed by device B vs. time, the energy absorbed vs. time. What is the total energy absorbed by device B after 3 hours?

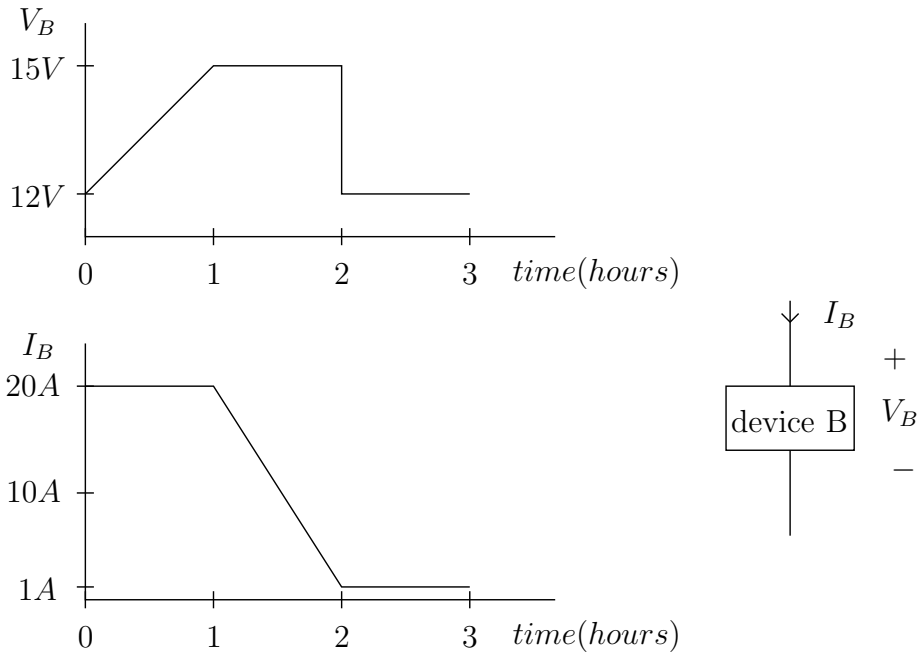

Figure 1:

3 Problem 3

Given the circuit in Figure 2 with $R_1 = 2\Omega$ and $R_2 = 1\Omega$.

a. If $R_3 = 100\Omega$, what are I_1 and I_2? What are the values of the power delivered for the 12V and 11.5V sources?
b. If $R_3 = 20\Omega$, what are I_1 and I_2? What are the values of the power delivered for the 12V and 11.5V sources?
c. If $R_3 = 10\Omega$, what are I_1 and I_2? What are the values of the power delivered for the 12V and 11.5V sources?
d. At what value of R_3 will I_1 and I_2 be equal?
e. At what value of R_3 will the power delivered by the two sources be equal?

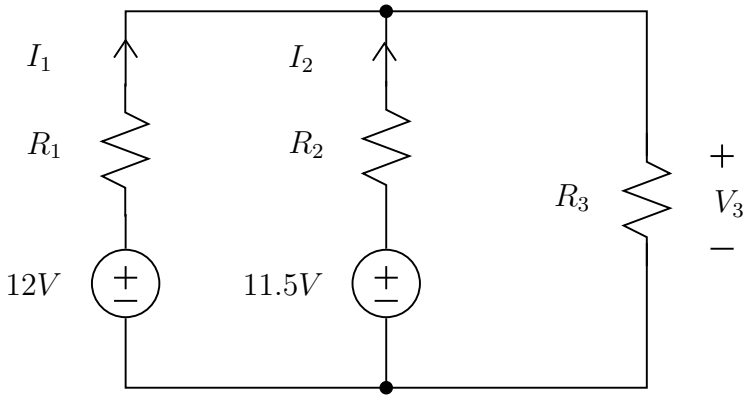

Figure 2:

4 Problem 4

Given the circuit in Figure 3.

a. Solve for the value of load voltage V_L that will give maximum power to the load in terms of R_1 and R_2.
b. If $R_1 = 2\Omega$ and $R_2 = 1\Omega$, what is V_L for maximum power?

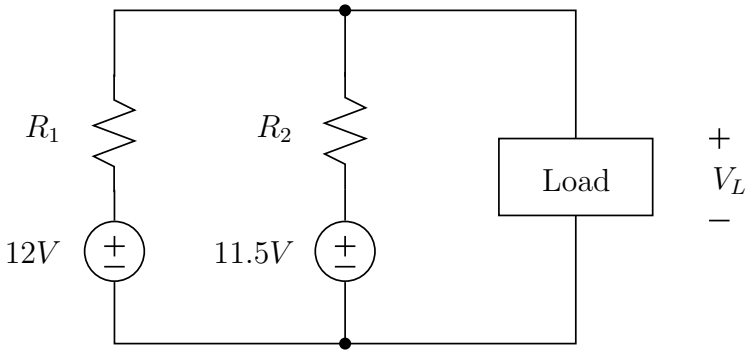

Figure 3:

5 Problem 5

Refer to the circuit in Figure 4. Solve for V_R using only KCL, KVL and Ohm's law. Clearly write down your solution.

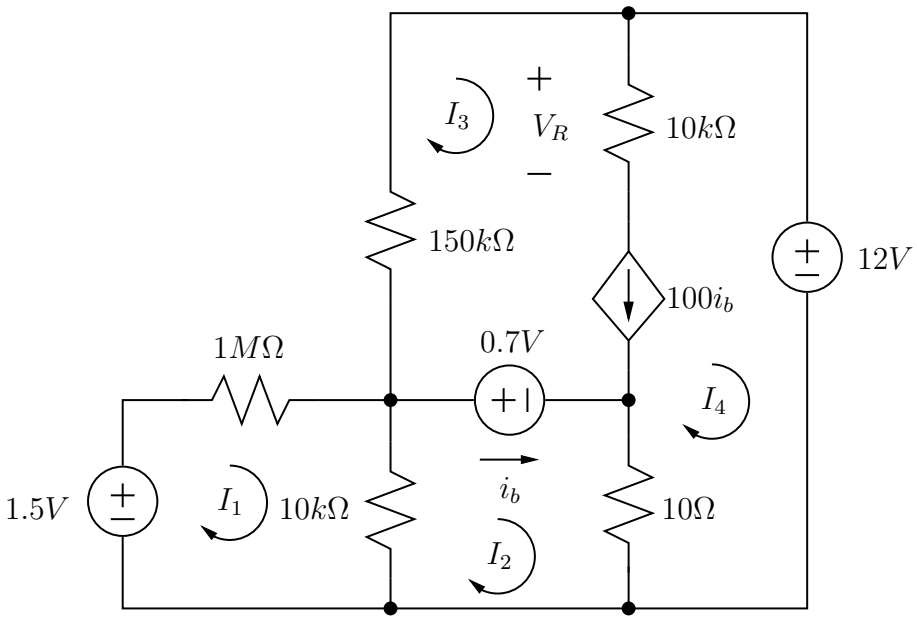

Figure 4:

6 Problem 6

Refer to the circuit in Figure 4.

a. Solve for V_R using the node voltage method. Setup your equations clearly.
b. Solve for V_R using the mesh analysis method. Setup your equations clearly.

7 Problem 7

The electric power produced in a hydroelectric power plant can be computed as

$$P = k\rho hgr \tag{1}$$

where P is the amount of power in $watts$, ρ is the density of water, h is the effective head of the water reservoir in m, r is the water flow rate in m^3/s, g is the acceleration due to gravity, and k is a constant that takes into account the plant's efficiency.

a. A 100 MW power plant is being supplied from a 200 m head and a flow rate of 150 m^3/s. Calculate the plant efficiency using $g = 9.81\ m/s^2$ and a water density of 1000 kg/m^3.

b. If energy is being sold at 5 pesos per kWh, how much (in Pesos) can this power plant potentially produce in one day? Do you think this is highly possible? What conditions will limit this possible earning?

c. A picohydro generator is a small hydro power plant. If its output is 5 kW, with a head of 2 m, how much energy can it potentially produce in one day?

d. If a typical household requires an average of 200 W of power, how many households can be supplied by this picohydro generator?

e. Suppose the picohydro is capable of operating continuously throughout the day, do you think the households connected to it will also use electricity at the same rate throughout the day? What do you think can happen in this situation. Discuss your ideas.

8 Problem 8

8.1 Voltages and Currents

Fill-up Table 8.1 by solving all the parameters indicated from the three separate circuits as shown in Fig. 5.

Parameter	Circuit 1	Circuit 2	Circuit 3
I_1			
I_6			
V_2			
V_{12}			

What observation can you draw from the values that you obtained?

8.2 Power Calculation

Complete the Table 8.2 below by calculating voltage, current and power for each component in circuit C. Consistently use the passive sign convention.

Component	Voltage (V)	Current (A)	Power (W)
$12V$ source			
$6mA$ source			
$1k\Omega$ resistor			
$2k\Omega$ resistor			
$6k\Omega$ resistor			
$12k\Omega$ resistor			

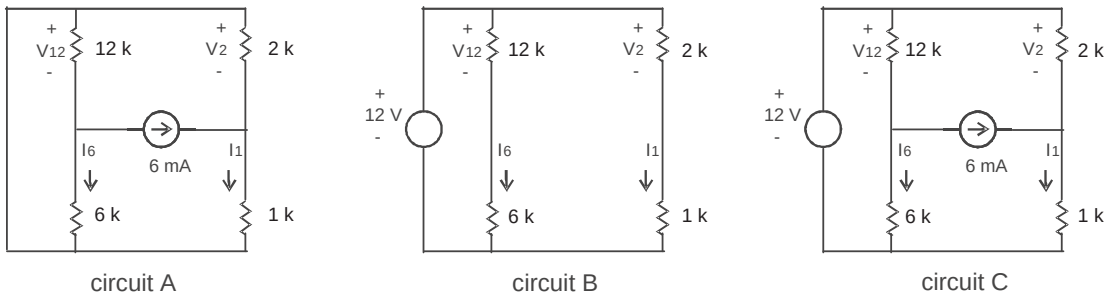

Figure 5: Circuits for Problem 2

9 Problem 9

Fig. 6 shows a circuit with 12 identical resistors and 9 nodes labeled a to i. Each resistor is $1k\Omega$.

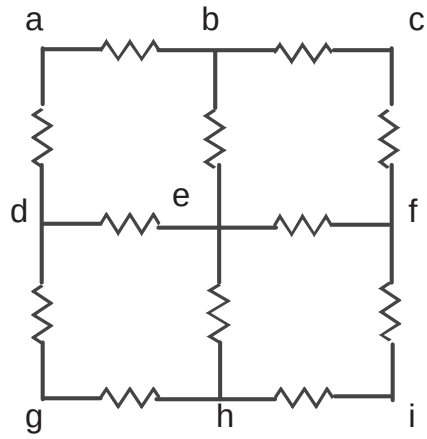

Figure 6: Resistors

9.1 Effective Resistances

a. What could be the highest resistance that can be measured across any pair of nodes? Specify a node-pair.

b. What could be the lowest resistance that can be measured across any pair of nodes? Specify a node-pair.

9.2 Branch Currents

If a 12 V DC supply is connected across nodes a and i, calculate the following currents

a. What could be the highest current that will flow through any resistor? Specify a node-pair for such resistor.

b. What could be the lowest current that will flow through any resistor? Specify a node-pair for such resistor.