Homework 1

Due Friday (5pm), Feb. 1, 2013

Please turn the homework in to the drop box located next to 125 Cory Hall (labeled EE 42/100).
Make sure to clearly label your Name, Student ID, Class, and Discussion sections on the homework.

1. A 9-V flashlight battery has a rating of 1.8 Wh. If the bulb draws a current of 100 mA when lit, determine the following:
   (a) For how long will the flashlight provide illumination?
   (b) How much energy in Joules is contained in the battery?
   (c) What is the battery’s rating in Ampere-hours?

2. Determine $R_{eq}$ at terminals $(a,b)$ in the following circuits.
   (a)
   ![Diagram](image1)
   (b)
   ![Diagram](image2)

3. Given that $I_1 = 3$ A in the circuit below, determine $I_0$.

   ![Diagram](image3)
4. Given the circuit below, determine:
   a) $I_X$
   b) $V_{ab}$
   c) $V_{da}$
   d) $V_{db}$
   e) Find the power associated with the 10V source. Is the power being delivered or dissipated by the 10V source? Justify your answer.

![Circuit Diagram](image)

5. [arbitrary coordinate systems] The four circuits below are identical except for the labeling of the resistor voltages. For each circuit, write KVL clockwise starting from ground, and write the expression for $I_1$, $I_2$, $V_1$, and $V_2$ in terms of $I_y$, and finally solve for $I_y$ in terms of $V_x$, $R_1$, and $R_2$. All of your equations should be identical except for the signs, and of course the final solution for $I_y$ should be the same for all circuits since it doesn’t depend on our choice of coordinates.

![Circuit Diagrams](image)
6. In one location where I charge my electric car, I plug the charging cable into an extension cord, and plug the extension cord into an office cubicle outlet. The office cubicle outlet is connected through a circuitous path back to the main building supply panel.
   a. The extension cord is made with three 14 gauge copper wires (often called 14/3 or “#14 two conductor plus ground”), and is 10m long. 14 gauge wire has a cross-sectional area of 2mm². Estimate the resistance of each conductor, $R_{\text{cord}}$.
   b. Assuming the car presents a resistive load $R_{\text{car}} = 10 \Omega$ when charging, the charging cable has a resistance of $R_{\text{cable}}$ per conductor, the extension cord has a resistance as above, and the resistance between the outlet and the supply panel is $R_{\text{cube}}$ per conductor, draw a schematic of the circuit.
   Before the car starts charging (0 amps flowing) it measures 124V on the line. Once it starts charging it pulls 12A, and measures 110V across $R_{\text{car}}$. When I measure the voltage at where the charging cable plugs into the extension cord, it reads 111V. When I measure the voltage where the extension cord plugs into the cubicle outlet, it reads 114V.
   c. Estimate the actual value of each of the resistors in your schematic. Why do you think that the cord resistance might be different from what you calculated?
   d. How much power is dissipated in the charging cable? the extension cord? the cubicle wiring?

7. Assuming a battery capacity of 24kWh (Nissan Leaf), how long does it take to fully charge an electric car from a 120V outlet at 12A? 208V outlet at 30A (upper Hearst lot charger)?

8. Tesla Motors has installed electric vehicle “superchargers” around the state that provide 255A at 350V. What is the power delivered by these chargers? How long does it take to charge an 85kWh battery (Model S)?

9. The total sunlight at noon on a clear summer day is just over 1kW/m². Assuming a solar panel with 20% efficiency, and an output voltage of 20V, estimate the output current of a one square meter panel in full sunlight.