EEE 31 Problem Set 1
Due:

1. Calculate the equivalent resistance R_{eq} of the network shown in Figure 1 below if $R_1 = 2R_2 = 3R_3 = 4R_4$, etc and $R_{11} = 3\ \Omega$.

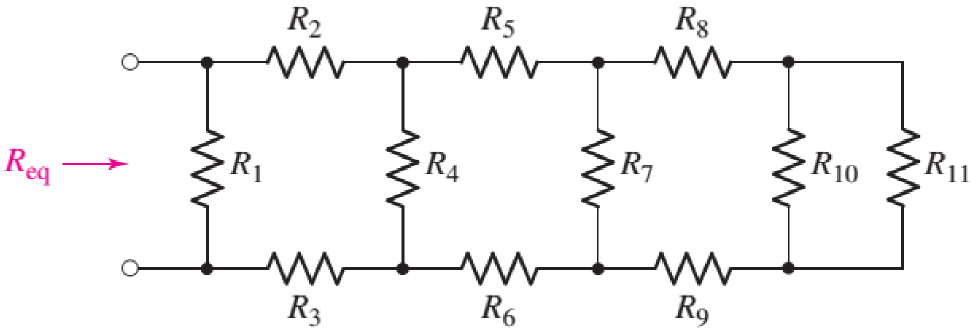

Figure 1

2. In the Figure 2 below, only the voltage $\mathbf{v_x}$ is of interest. Simplify the circuit using the appropriate resistor combinations and iteratively employ voltage division to determine $\mathbf{v_x}$.

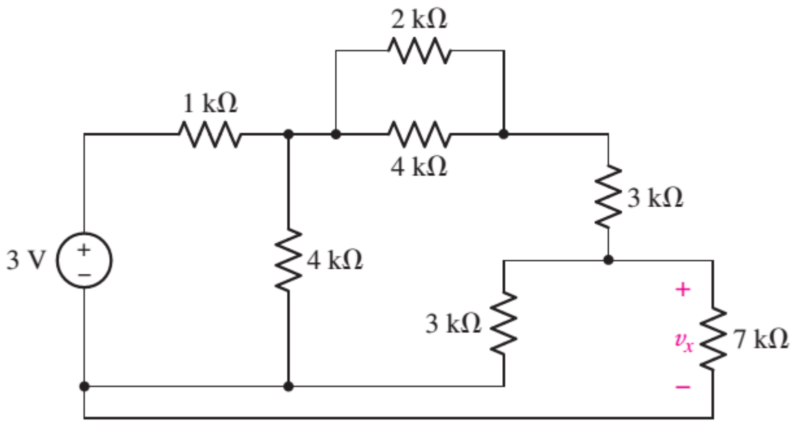

Figure 2

3. The 600 kΩ resistor is connected from the 200 V terminal to the common terminal of a dual-scale voltmeter, as shown in Figure 3.(a) below. This modified voltmeter is then used to measure the voltage across the 360 kΩ resistor in the circuit in Figure3.(b).

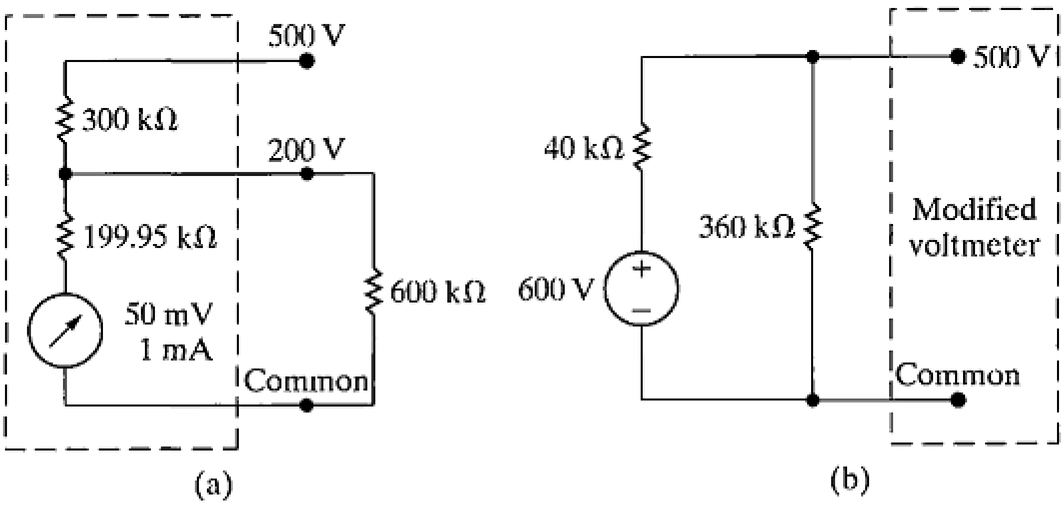

Figure 3

EEE 31 Problem Set 1
Due:

a. What is the reading on the 500 V scale of the voltmeter?
b. What is the percentage error in the measured voltage?

4. Use Y-to-Δ transformation to find i_1, i_2 and i_o and the power delivered by the ideal current source in the Figure 4 below.

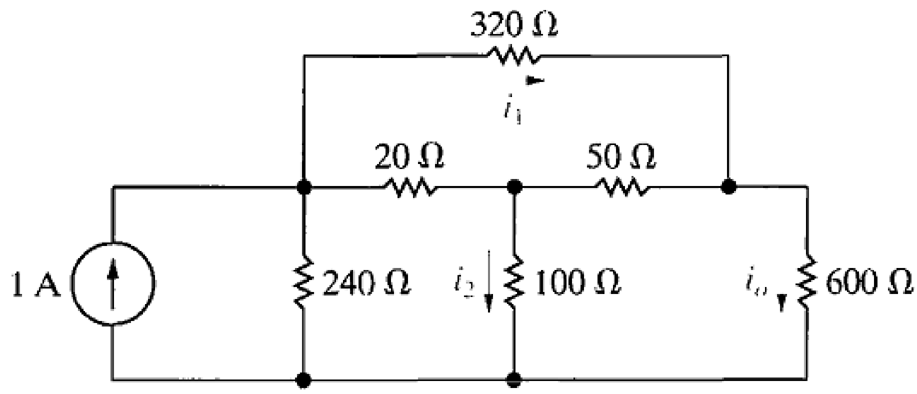

Figure 4.

5. Using the bottom node as reference, determine the voltage across the 5 Ω resistor in the Figure 5 below, and calculate the power dissipated by the 7 Ω resistor.

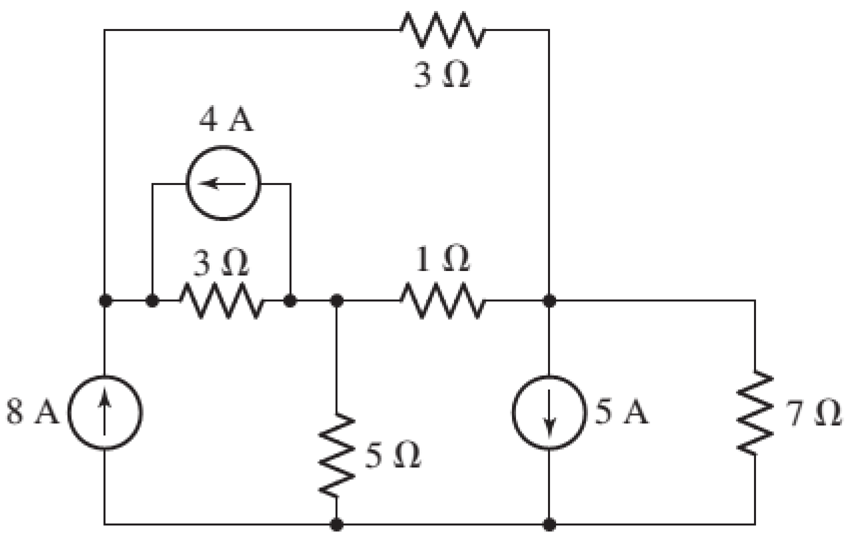

Figure 5

6 Problem 6

In circuit experiments, it is helpful to have a visual indication of circuit activity. A light emmiting diodes (LED) is a circuit element that emits light when current passes through it. An LED is often used in a circuit to give that visual indication. The circuit symbol for an LED is shown below. When current passes through the LED, we can approximate the LED as a 1 V source in series with a 10 Ω resistance as shown in the LED model below. A commonly used LED has a maximum current rating of 30 mA.

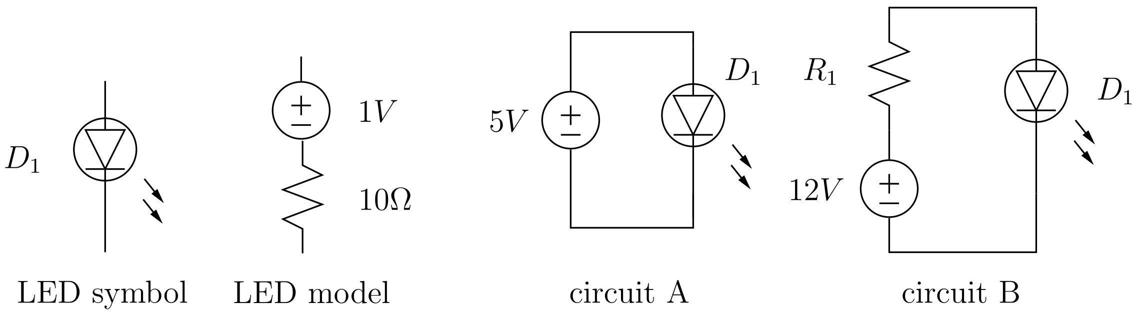

Figure 1:

a. To test LEDs, students often haphazardly connect the LED as shown in circuit A. Is this a good idea? Why or why not?
b. In circuit B, what is the range of values for R_1 that would avoid the failure of the LED.
c. If the single LED in circuit B is replaced by two LEDs (pointing in the same direction) in series, what is the range of values of R_1 that would avoid LED failure.

7 Problem 7

A gasoline powered vehicle traveling at a constant speed of 100 km/hr can go 15 km for every liter of gasoline. Gasoline has an energy density of 32.4 MJ/liter. A gaoline powered vehicle has an overall "tank-to-wheel" efficiency of about 25%, i.e., only 25% of the energy content of the gasoline is converted into usable power to move the vehicle; the rest is lost to heat.

An electric powered vehicle uses energy stored in batteries to power an electric motor that eventually drives the vehicle. An electric vehicle has a "battery-to-wheel" efficiency of about 85%. However, before an electric vehicle can be used, the batteries must first be charged from a power outlet. The charging operation is around 80% efficient.

a. If electricity cost P10 per kW-hr, how much does a liter of fuel need to cost in order for the fuel cost of running the gasoline vehicle to be the same as the electricity cost of running the electric vehicle.
b. How much power does the electric motor deliver when the vehicle is running at 100 km/hr? How much power is being drawn from the batteries at this speed?
c. If the battery voltage is 300 V, how much current is drawn from the batteries at 100 km/hr? If the electric vehicle has a 40 ampere-hour battery, what distance can it travel on a full charge?

8 Problem 8

Shown in Figure 2 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?

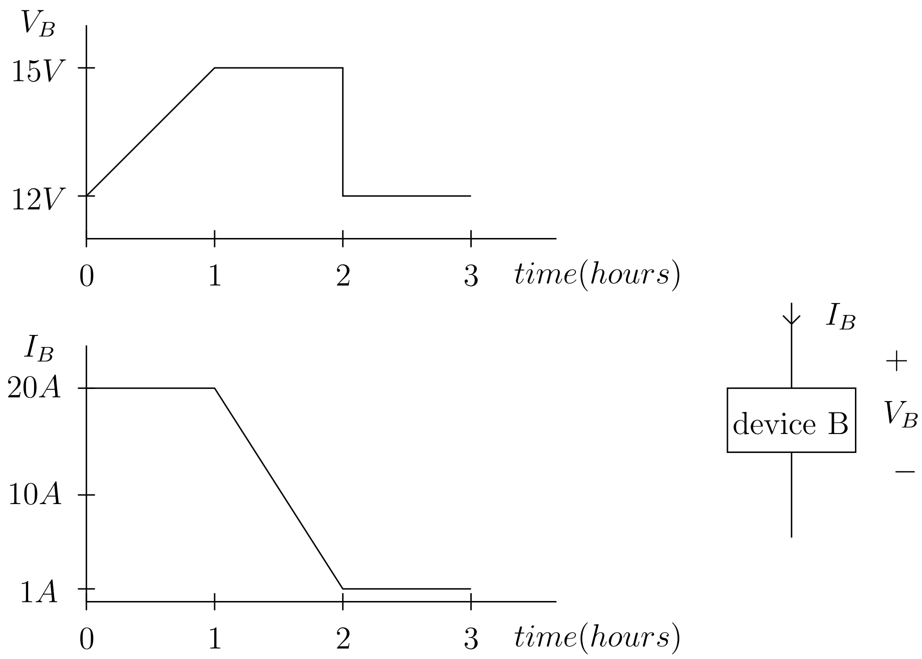

Figure 2:

9 Problem 9

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?

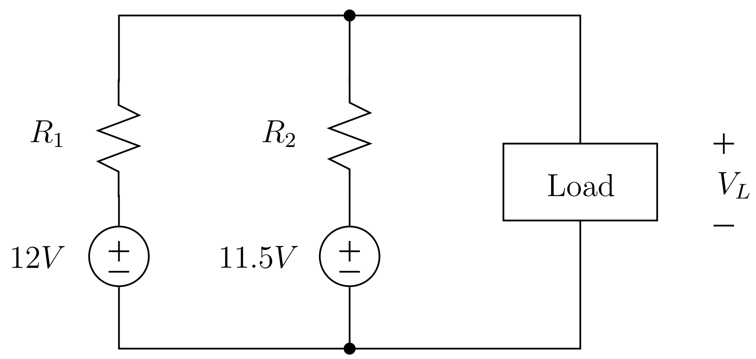

Figure 3:

10 Problem 10

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

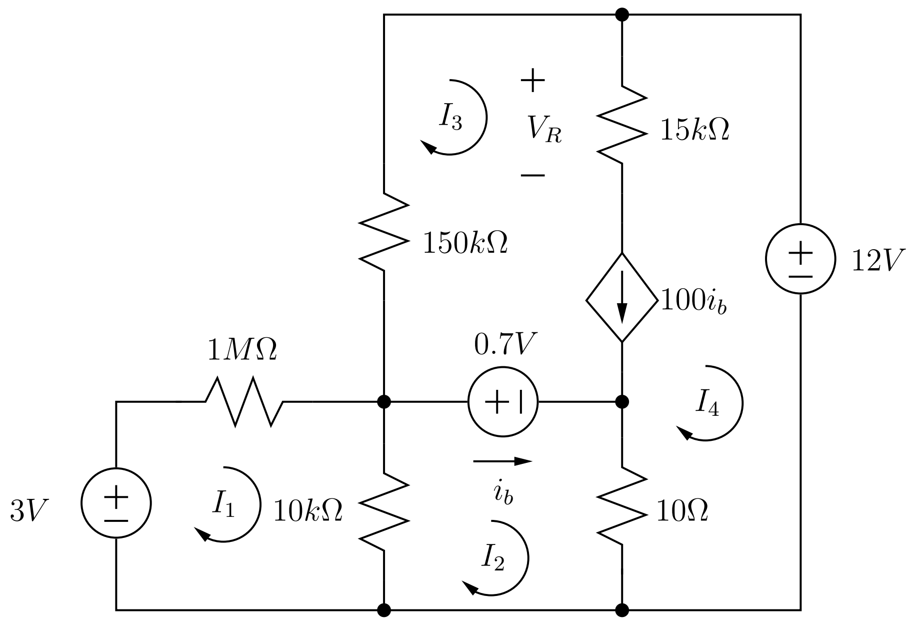

Figure 4:

11 Problem 11

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.