Name: _____ Lab section/TA: _____

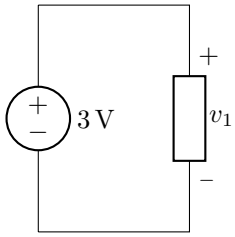
ENGR 40M Problem Set 1

Due 1:30pm, July 7, 2017

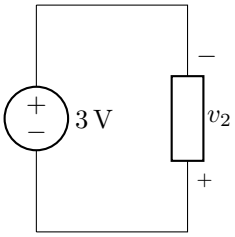
Homework should be submitted on Gradescope, at `http://www.gradescope.com/`. The entry code to enroll in the course is available at `https://web.stanford.edu/class/engr40m/restricted/gradescope.html`.

Problem 1: Reference directions

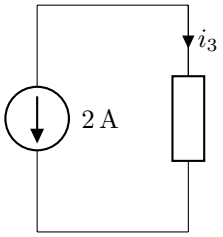
(8 points) Write down the labeled voltages and currents. Pay attention to the reference directions drawn on the components. Don't forget to write the unit.



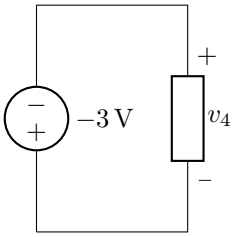
$v_1 =$ _____



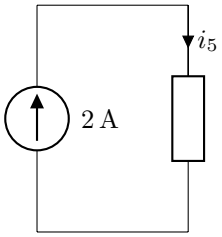
$v_2 =$ _____



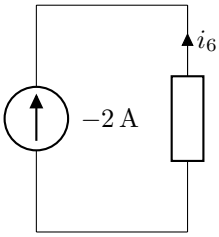
$i_3 =$ _____



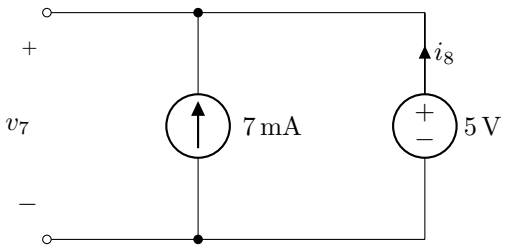
$v_4 =$ _____



$i_5 =$ _____



$i_6 =$ _____

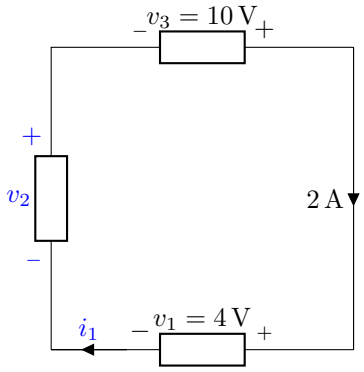


$v_7 =$ _____

$i_8 =$ _____

Problem 2: Kirchoff's laws

(5 points) Consider the following circuit:



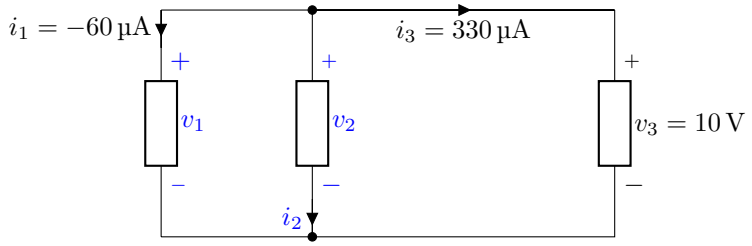
(a) Find the current i_1.

(b) Find the voltage v_2.

(c) Find the power dissipated by each element in the circuit. Use the convention that positive power means that the device absorbs energy from the circuit, and negative power means it supplies energy.

Problem 3: More of Kirchoff's laws

(6 points) Consider the following circuit:



(a) Find the current i_2.

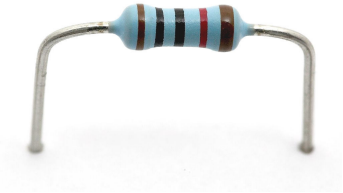
(b) Find the voltage v_1.

(c) Find the voltage v_2.

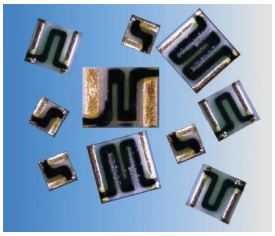
(d) Find the power dissipated by each of the three elements in the circuit.

Problem 4: Power dissipation

(4 points) Resistors come in lots of different shapes and sizes. Most resistors that we'll use in this course are through-hole resistors, pictured below left. In miniature designs, though, much smaller resistors are used. The chip resistors pictured below right are known as "0202"-sized resistors. They measure about 0.5 mm × 0.5 mm × 0.375 mm—pretty small and tough to solder!



through-hole resistor



0202 resistor

The other catch with such small resistors is that they can't handle very much power. We call the maximum power that a resistor can handle without getting damaged the *power rating* of the resistor. The pictured resistors are *rated* at just 40 mW at room temperature. It is the responsibility of the circuit designer to ensure that the circuit doesn't cause them to dissipate that much power (or to use a different-sized resistor).

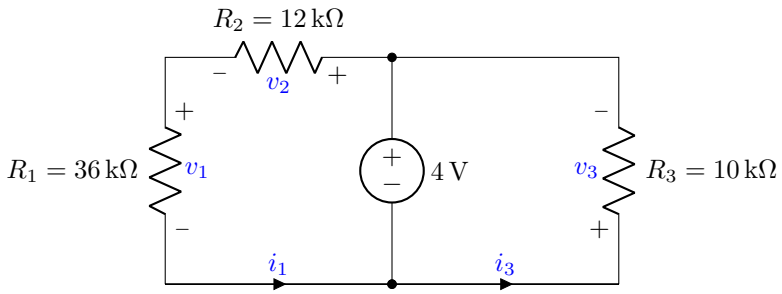
(a) Determine the maximum DC voltage that can be applied across an 0202-sized resistor of resistance 10 kΩ, without exceeding the power rating of the resistor (that is, before the resistor dissipates more power than it can without getting damaged).

Another limit on these resistors is called the *breakdown voltage* or *flashover voltage*. Above the voltage, the current can take a shortcut around the resistor, for example, by arcing through air. The resistor pictured above has a breakdown voltage of 50 V.

(b) What is the range of resistance values for which an 0202 resistor will experience breakdown, before it burns up due to exceeding the 40 mW power rating?

Problem 5: More circuits

(9 points) Consider the following circuit. Pay attention to the reference directions given on the circuit diagram!



(a) Find the voltages v_1, v_2 and v_3.

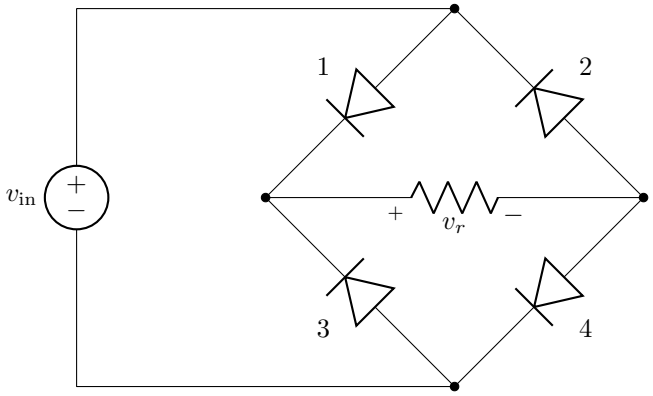
(b) Find the currents i_1 and i_3.

(c) Find the power dissipated by each of the three resistors.

(d) Find the power supplied by the voltage source (*i.e.*, the negative of the power dissipated by the voltage source).

Problem 6: Diodes

(4 points) Assume that the diodes are ideal (*i.e.*, they have zero forward voltage).



(a) Suppose $v_{in} = 6\,\text{V}$. Which diodes turn on? What is the resistor voltage, v_r?

(b) What if v_{in} is reversed, to $-6\,\text{V}$? Which diodes turn on now, and what is the resistor voltage, v_r?

(c) Bonus: Can you think of any uses for a circuit like this? Here the resistor just represents a load (*i.e.*, it's a substitute for any power-consuming circuit).

Problem 7: Reflection

(2 points)

(a) How long did it take you to complete this assignment?

(b) Which problem was the most difficult, and why?