# PHYS605

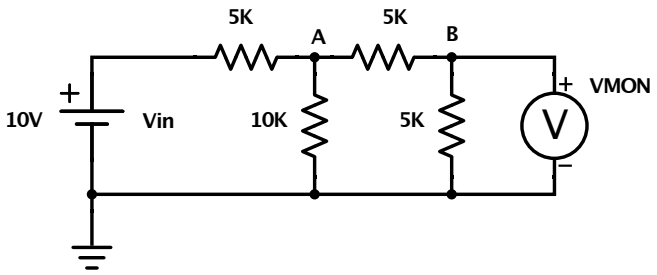
HOMEWORK 1

**DUE THURSDAY FEB 7, 2019.**

## RESISTORS

1) Write a Python (or C/C++, or Java) resistor calculator.
   a) Make sure your code is really well documented!
   b) Beginning coders:
      i) Write a *function* for series, and another for parallel that takes two values and returns the series or parallel equivalent value. Test your functions.
      ii) Extend the functions so that they can accept a *list of values*, instead of just 2. Test your functions.
      iii) Write a *function* that accepts an input voltage, and R1 and R2, and returns the output voltage value for a divider circuit (figure 2.43 in your book, lower part).
   c) Advanced coders:
      i) Write a *class*, Resistor, with the properties such that operator + computes the series and operator * computes the parallel value of two such objects, returning a new Resistor object. Test your code.
      ii) Extend your class so that it also takes into account the maximum *power* (i.e. 1/8 Watt) for each resistor, and correctly computes this for the resulting resistor.
      iii) Use your resistor class to create a function for a divider circuit.

2) Consider the circuit shown here of an R2R ladder, with two output terminals, to which a voltmeter is connected, as shown in the figure.
   a) Sketch the Thévenin equivalent of the R2R ladder, as seen by the voltmeter. Find the correct values for $V_{th}$ and $R_{th}$.
   b) Sketch the output voltage (Vmon), as seen by the voltmeter, versus the input voltage (Vin) from the power supply.

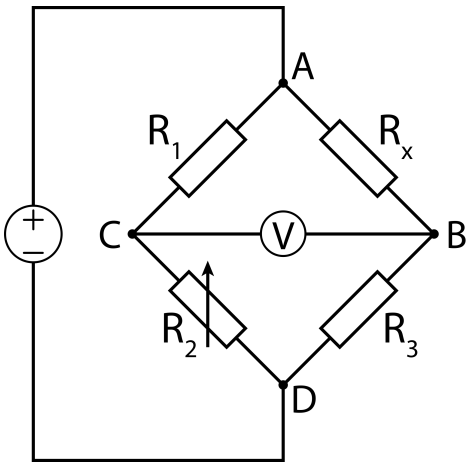



3) For an circuit in the lab you need a resistor that has the value 5.4 kΩ, which needs to have a power rating of at least ½ Watt. Your resistor kit only has 1/8 Watt, 1% accurate, resistors, and only has the values that are given in the table below.
   a) Design a circuit combining resistors that has the correct properties for what you need.
      i) Use some first principles: What is the minimum number of resistors that could do this, if you could use any value you wished?
      ii) Hint: the simplest solution has 9 resistors!

| | | | |
|---|---|---|---|
| 10 Ω | 100 Ω | 1.0 kΩ | 10 kΩ |
| 15 Ω | 150 Ω | 1.5 kΩ | 15 kΩ |
| 22 Ω | 220 Ω | 2.2 kΩ | 22 kΩ |
| 33 Ω | 330 Ω | 3.3 kΩ | 33 kΩ |
| 47 Ω | 470 Ω | 4.7 kΩ | 47 kΩ |
| 68 Ω | 680 Ω | 6.8 kΩ | 68 kΩ |

b) What is the maximum voltage that you can put across this combined resistor network and not burn out any of the resistors?

4) Consider the circuit in the diagram to the right. This setup of resistors (sorry, the picture is using the European symbol for resistors, a rectangular box) is called a Wheatstone Bridge. The power supply (circle with + and -) has a voltage Vin
   a) Calculate the reading of the voltmeter in terms of R1, R2, R3 and Rx.
   b) Consider R1=R3=1kΩ, R2 is variable, and Rx is a light sensitive resistor, called a photoresistor, which without any light has a value Rx(0)= 1.2 kΩ. What value do you need to set R2 so that the volt reading is zero?
   c) When light falls on the photoresistor its resistance decreases. Consider that some light falls on the photoresistor and the value is decreased by about 10% to 1.1 kΩ. What is now the reading on the voltmeter?




## I-V CURVES

Go to the circuit simulation at: https://www.partsim.com/simulator#69733

Create a free account for yourself at “Partsim” (they don’t need a phone number, you can use 18005551212), so that you can save the circuits you designed. After you registered, you can go back the link above, and now you can click “save” and save a copy of the circuit under your own account.

Run the simulation as it is. Use a “DC sweep”, and a start voltage of -10, a stop voltage of 10 and a step of 0.1. After you click on “Run” (bottom right) you should get the curves for the current and the voltage. This is NOT an I-V curve, but it can be used to construct one.

Now go back to the simulation, and remove the diode that is there. Instead put in a Fairshield Semiconductor 3.3 V Zener diode, model 1N5226B, then run the simulation again. From the I and V curves that you get, create an I-V curve. (Hint: on the top right is a button to save the data as a csv file, which you can import into Python and then make plots using Matplotlib.)

Play around with this simulation. Change parts, try things, and report anything that you did, especially if you thought it was interesting.