MASSACHUSETTS INSTITUTE OF TECHNOLOGY

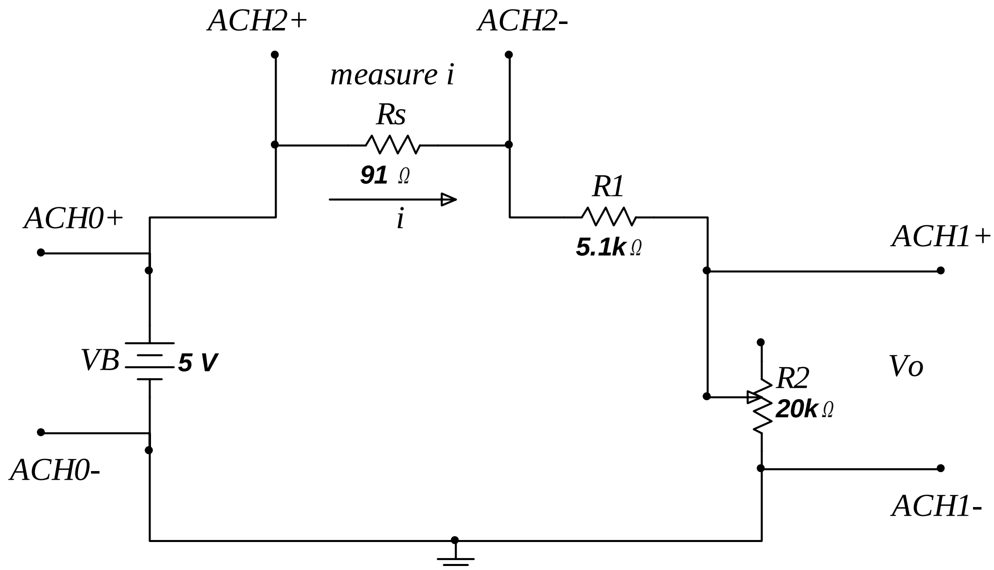
22.071/6.071 Introduction to Electronics, Signals and Measurement

Spring 2006

Lab8. Equivalent circuits, Power Transfer

With this exercise we will explore the concept of equivalent circuits and power transfer.

Let's start with the circuit shown below. The terminals labeled *ACH0+, ACH0-, ACH1+,* etc. are used for performing measurements of the circuit at the corresponding nodes.



In this circuit the resistor *R2* represents the load resistance. *Rs* is a current sensing resistor and its value is small compared with the other resistors in the circuit. By knowing the value of *Rs* a simple measurement of the voltage drop across it gives us the amount of current flowing through it.

Before proceeding with the experiment do the following calculations:

1. Derive an expression for *R2* as a function of *VB, Vo*, *R1,* and *Rs*.

2. For $Rs \ll R1$ and $R2$, derive the expression for the power dissipated in *R2* as a function of the circuit parameters.

Now construct the circuit on your protoboard and make the connections as indicated. For *R2* use your 20kΩ variable resistor. For *Rs* use a 91Ω resistor.[1]

Download the instrument called "**Power_Transfer_1**" from the class web site. Run it and vary *R2*. Observe the behavior of the circuit.

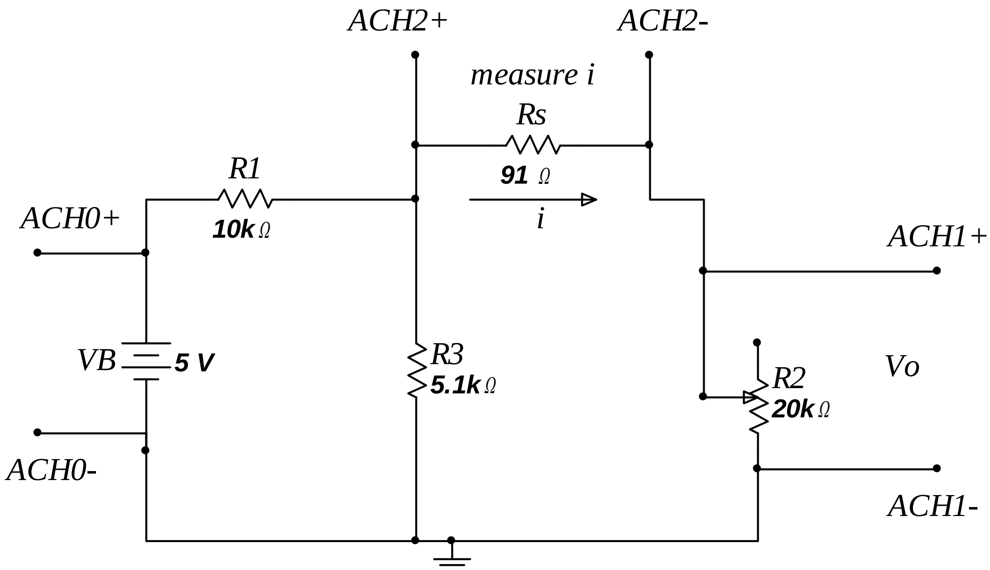
At what resistance is the power dissipated in *R2* maximized?

In the space below draw the power dissipated in *R2* as a function of *R2*.

Does your experimental result agree with your calculations?

[1] Any other resistance values could be used for Rs and R3. But since we have the 91Ω and the 5.1kΩ in our kit we use these.

Now let's modify the circuit by changing *R1* to 10kΩ and adding the 5.1kΩ *R3* resistor as indicated in the schematic below. Again use a 91Ω resistor for *Rs*.



Before proceeding with the experimentation with this circuit let's analyze it.

1. Determine the Thevenin equivalent circuit seen by resistor *R2*.

2. Calculate the voltage *Vo* across resistor *R2* as a function of the circuit parameters.

Download the instrument called "**Power_Transfer_2**" from the class web site. Run it and vary *R2* and observe the behavior of the circuit. (Note: turn the previous instrument **Power_Transfer_1** off before proceeding with this one)

The instrument measures the power dissipated in *R2* and plots it as a function of *R2*. This is accomplished while you are trimming (changing the value) of the variable resistor *R2*.

In the space below redraw the results you are observing from the measurements

At what value of *R2* does the power dissipated in *R2* becomes a maximum in this case?

Do you see how that optimum value is related to *R1* and *R3*? (We still have $Rs \ll R1, R2,$ and $R3$).