Name:_____

Massachusetts Institute of Technology
Department of Nuclear Science and Engineering
Department of Electrical Engineering and Computer Science

22.071/6.071 – Introduction to Electronics, Signals and Measurement
Spring 2006

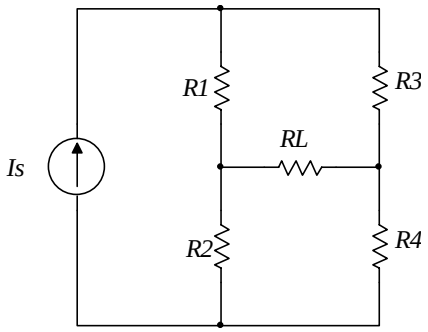
Quiz 1

- Please write your name on each page of the exam in the space provided
- Please verify that there are 12 pages in your exam.
- To the extent possible, do your work for each question within the boundaries of the question or on the back side of the page preceding the question. Extra pages are also provided for computation.
- Note that the total number of points is 100.
- Closed book. No Calculators

Name:_____

Problem 1 - (10 points)

For the Wheatstone bridge circuit shown below determine the Thevenin equivalent circuit seen by resistor *RL*.



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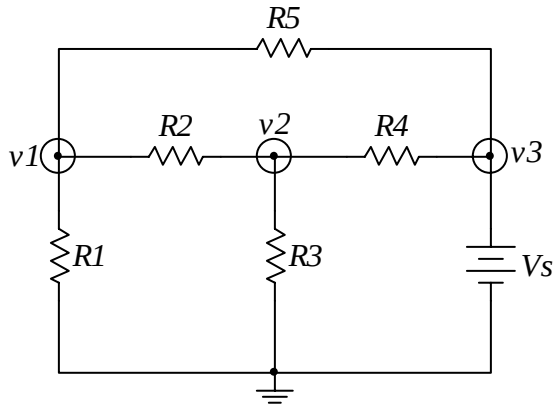
Problem 2 - (15 points)
Using nodal analysis, derive and put in matrix form the equations for the node voltages of the following circuit.



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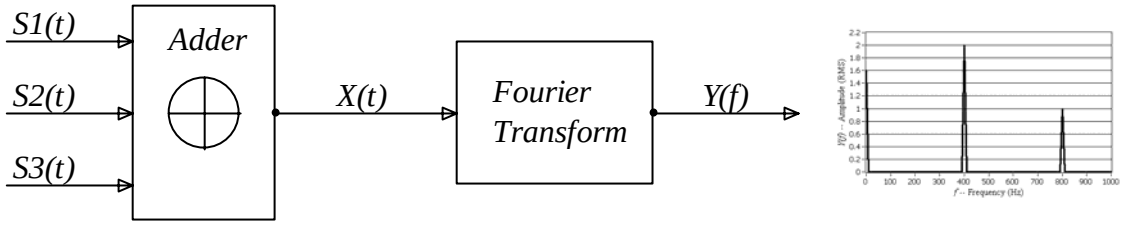
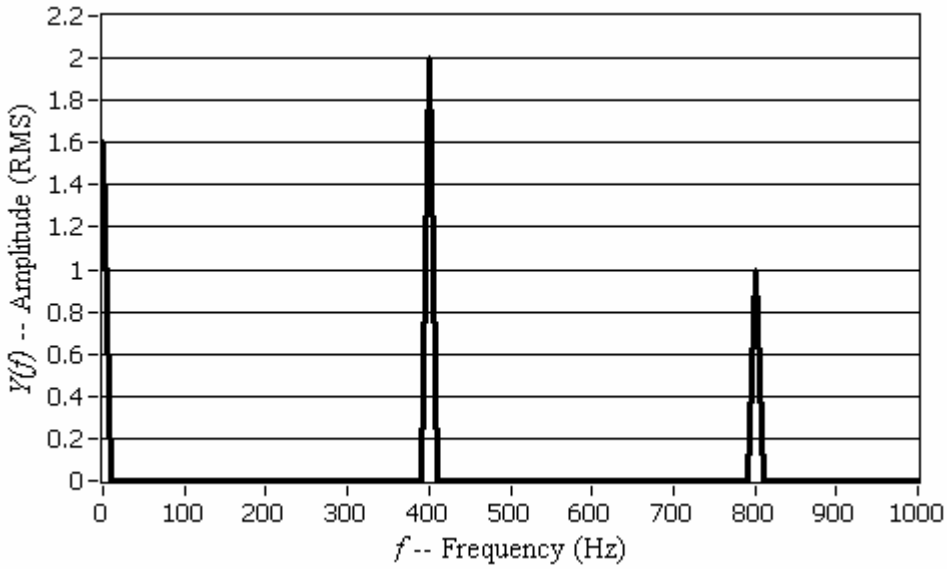
Problem 3 - (10 points)

Signals *S1(t), S2(t)* and *S3(t)* are operated upon by the adder resulting in the output signal *X(t)*. In turn the Fourier transform of signal *X(t)* is determined resulting in the signal *Y(f)*.



The Fourier Transform, *Y(f)*, of the signal *X(t)* is given on the following plot. The vertical axis represents the RMS amplitude of the signal and the horizontal axis is the frequency *f* in Hz. The system is linear and so each peak shown on the *Y(f)* versus *f* plot is associated with only one signal.



A. From the information given above reconstruct the general form of signals *S1(t), S2(t)* and *S3(t)*.

B. What is the minimum sampling frequency of signal *X(t)* in order to avoid aliasing?

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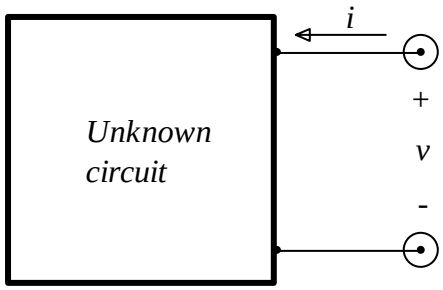
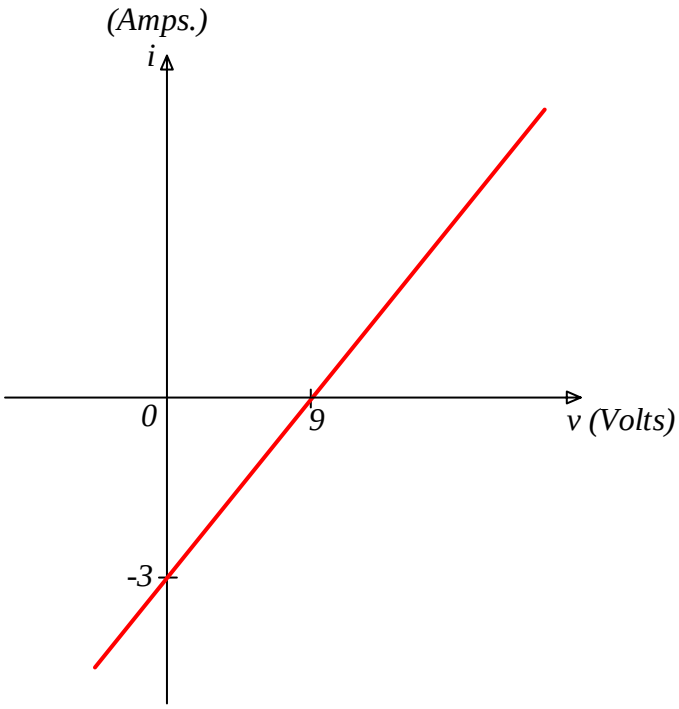
Problem 4 - (10 points)

A certain unknown circuit has the i-v characteristic shown below.





From the information given in the i-v plot determine the Thevenin and the Norton equivalent circuits of the unknown circuit.

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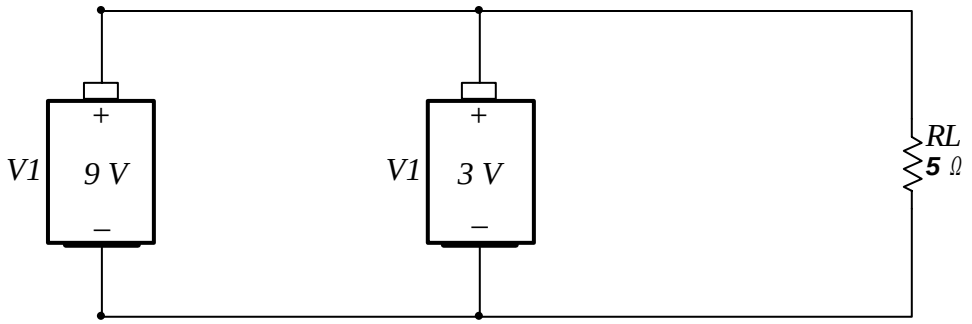
Problem 5 - (15 points)
The following circuit was built by a person named Egatlov who did not take 6.071. *V1* and *V2* are batteries with the voltage and polarity as indicated in the circuit.



A. What is wrong with Egatlov's circuit?

B. Egatlov notices that the batteries were getting warm and that they did not really last that long. Your task is to explain to Egatlov why this happens.

By assuming that each battery has an internal resistance Ri=5Ω draw the circuit to include the internal resistance of the batteries.

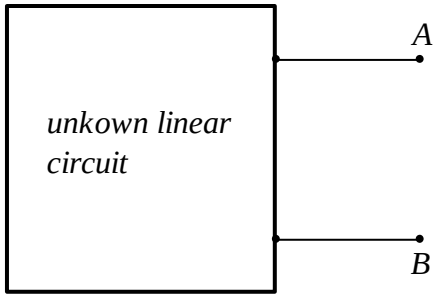
C. Calculate the power dissipated in each battery.

D. Calculate the power dissipated in *RL*.

Name:_____

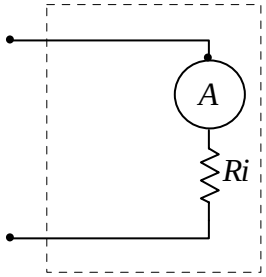
Problem 6 - (20 points)

The box shown below represents an unknown linear resistive network for which we would like to obtain the Thevenin equivalent circuit.



In order to obtain the Thevenin equivalent circuit we will use a voltmeter to measure the voltage across terminals A-B and an ammeter in order to measure the current across A-B.

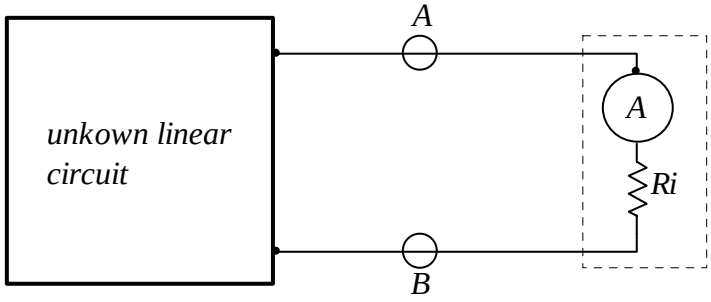
The voltmeter is an ideal device with infinite input resistance.
The ammeter is characterized by an internal resistance *Ri* as shown in the following model.



Using the voltmeter you measure a voltage of 20 Volts across A-B.

With the ammeter you perform the following two measurements.

1) Connect the ammeter as indicated to measure a current of 2.0 A.



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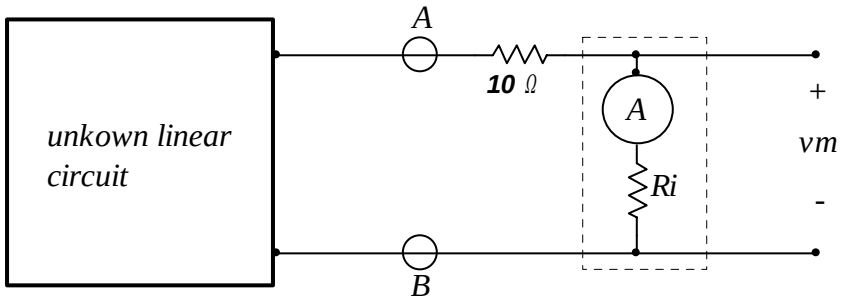
2) Now by using the following arrangement you measure a current of 1.0 A and a voltage *vm*=2.0 Volts across the ammeter as indicated.



A. From the above measurements determine the Thevenin equivalent circuit of the unknown device.

B. Draw the general *i-v* characteristic curve of the unknown device.

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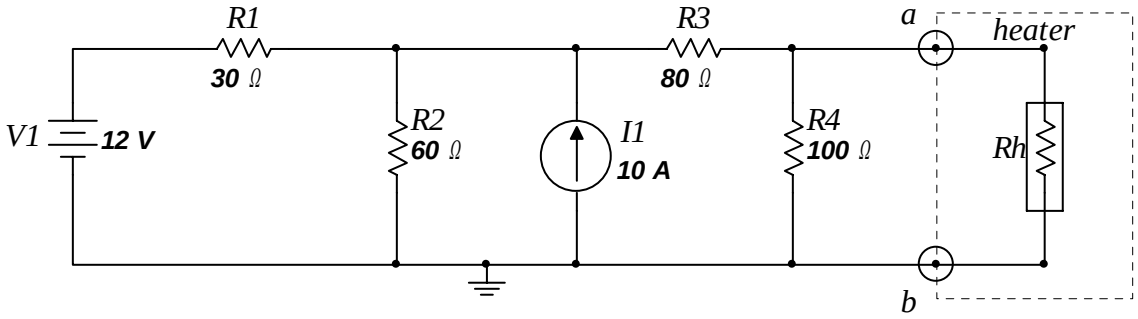
Problem 7 - (20 points)

It is desired that the power delivered to the heater by the balance of the circuit as indicated is a maximum.



A. Determine *Rh* for maximum power transfer.

B. What is the maximum power dissipated by the heater

C. Which source (*V1* or *I1*) delivers most of the power to the heater?

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Problem	Points
1	
2	
3	
4	
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Total	