Chemistry 838 - Hour Exam 1

Fall 2007

Department of Chemistry
Michigan State University
East Lansing, MI 48824

Name	
Student Number	

Question	Points	Score
1	15	
2	15	
3	15	
4	15	
5	15	
6	15	
7	15	
8	15	
9	15	
Total	105	

Answer any 7 of the 9 questions. All parts of a given problem are worth the same number of points unless noted in the problem. The number of points earned on this exam will be added to your total points for determination of the final course grade. Notice that you may earn 5 bonus points above the advertised 100 points for this exam. Do your work on these pages. Use the backs of the pages for extra space if necessary.

The exam is closed book. Calculators are allowed. A straight edge is desirable.

Question 1 Data Acquisition and Display

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An experiment produces two periodic signals **A** and **B**. Two cycles of these signals are shown in Figure 1. Repetitive acquisitions of the portion of the signal located between the times 1400 to 1700 (See Figure 2) in the first cycle are to be acquired.

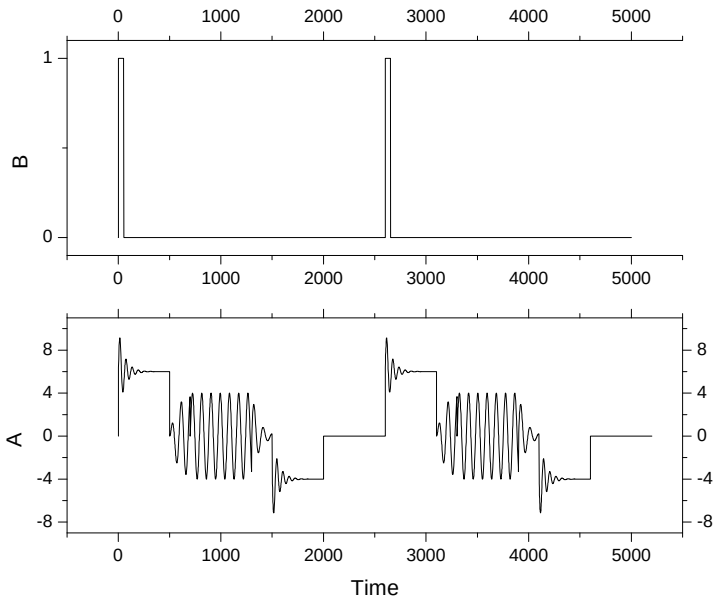

Figure 1

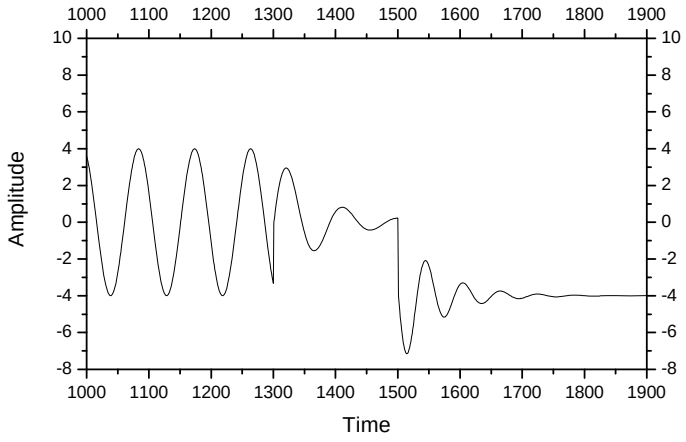

Figure 2

Question 1 Data Acquisition and Display

Discuss two different strategies for making such an acquisition that will result in only data in the desired intervals being acquired. Include a general description of what facilities would be needed. Include values for all pertinent parameters such as acquisition window extrema, beginning of acquisition criteria, etc.

Question 2 DC Circuit Analysis

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The circuit in Figure 3 has the values: $\mathbf{V_1}$ = 12.0 volts, $\mathbf{R_1}$ = 12 kΩ, $\mathbf{R_2}$ = 4 kΩ, $\mathbf{R_3}$ = 16 kΩ, $\mathbf{R_4}$ = 16 kΩ. What is the value of $\mathbf{V_2}$? Show your work.

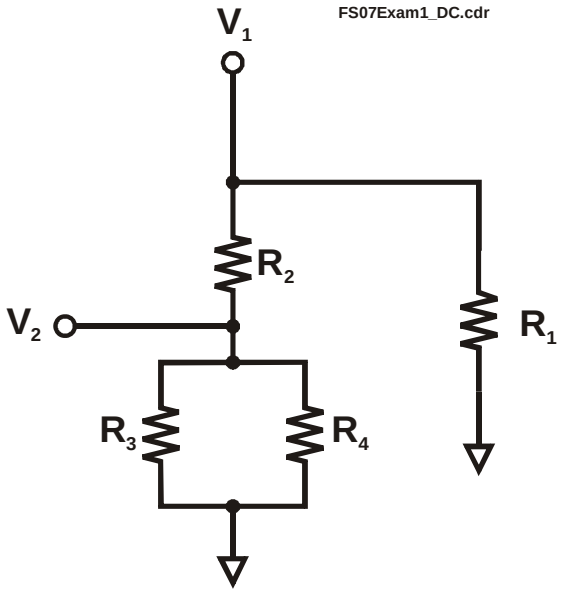

Figure 3

Question 3 Power Supplies

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The circuit in Figure 4 has the input $\mathbf{V_1}$, which is a 60 Hz sign wave with a peak-to-peak amplitude of 160 volts. Assume that $\mathbf{n_s} = 5$ and $\mathbf{n_p} = 50$.

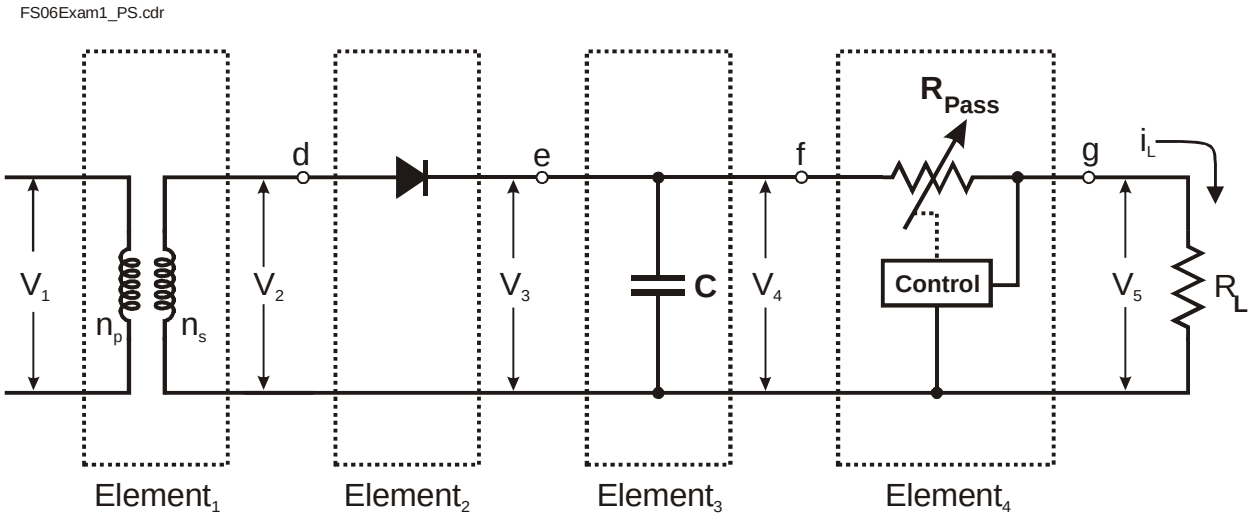

Figure 4

a) (5 points) What is the goal of this circuit?

Question 3 Power Supplies

b) (5 points) What is the role of ***Element$_1$*** in this circuit?

c) (5 points) What is the role of ***Element$_4$*** In this circuit?

Question 4 AC Circuits

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a) (8 points) Sketch the circuit schematic diagram for a first order high pass filter.

b) (7 points) Sketch the bode plot for the first order high pass filter. Label the axes and tick marks.

c.) (3 Points) What is meant by the term f_0? How is the value of f_0 related to the circuit parameters of the first order high pass filter?

Question 5 Loading

Question 5 Loading

Figure 5 illustrates an attempted voltage measurement of a real voltage source that can be modeled as an ideal source, $\mathbf{V_S}$, in series with a resistance, $\mathbf{R_S}$. The voltage reading is reported by a real voltage meter that can be modeled as an ideal voltage meter that displays the value of $\mathbf{V_M}$ and has an input resistance, $\mathbf{R_M}$, between the inputs. If $\mathbf{R_S}$ = 2KΩ, $\mathbf{R_1}$ = 4KΩ, $\mathbf{R_2}$ = 4K Ω, $\mathbf{R_M}$ = 1 MΩ, and the **VMD** reports -8.0 volts, answer the following questions. Assume that $\mathbf{i_+ = i_- = i_{M+} = i_{M-} = 0}$ and the operational amplifier is operational.

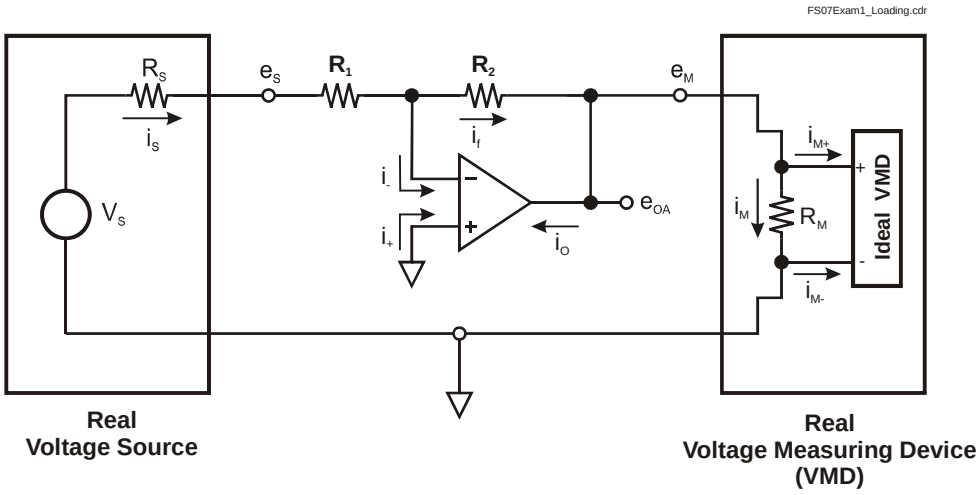

Figure 5

Answer the following questions. Show your work.

a) (3 points) What is the value of the current i_M?

b) (3 points) What is the value of the current i_S?

Question 5 Loading

c) (3 points) What is the value of the voltage $\boldsymbol{es}$?

d) (3 points) What is the value of the source voltage $\mathbf{V_S}$?

e) (3 points) Is this a good measurement? Explain.

Question 6 Diodes

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Diodes can be used as to rectify AC signals.

a.) (7 points) Sketch the characteristic curve of a diode. Label the axes and the three regions of operation.

b.) (8 points) Discuss the attributes of the diode that make it a desirable device for rectification. Include in your discussion any characteristics of the diode that are important in choosing a particular diode for use in this application.

Question 7 Operational Amplifiers

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If $\mathbf{R_1}$ = 8 KΩ, $\mathbf{R_2}$ = 8 KΩ, $\mathbf{R_3}$ = 16 KΩ, $\mathbf{R_4}$ = 4 KΩ, $\mathbf{R_5}$ = 12 KΩ, $\mathbf{e_3}$ = +6 volts, and $\mathbf{e_4}$ = -3 volts, answer the following questions for the circuit shown in Figure 6. Assume that $\mathbf{i_+} = \mathbf{i_-} = 0$ for all three operational amplifiers, and that all three operational amplifiers are operational.

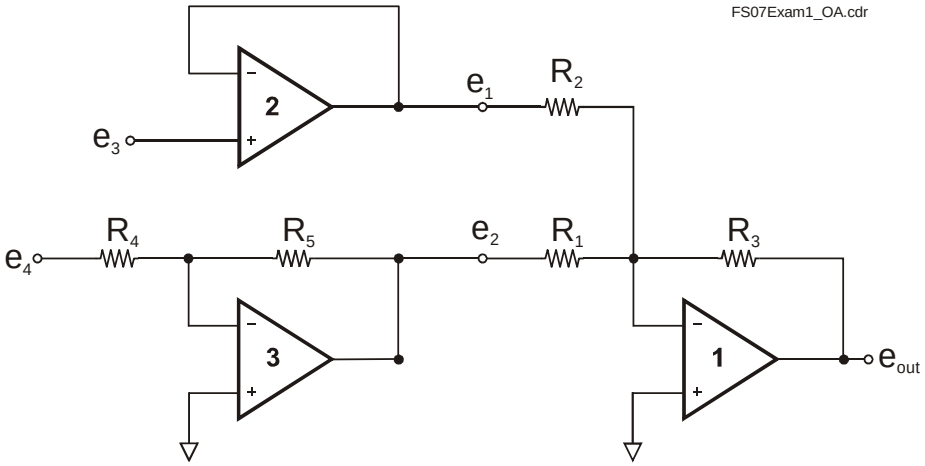

Figure 6

a.) (5 points) What is the value of $\boldsymbol{e_1}$?

b.) (5 points) What is the value of e2?

c.) (5 points) What is the value of $\boldsymbol{e_{out}}$?

Question 8 Time and Frequency

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Signal ***A*** and Signal ***B*** are to be connected to the circuit shown in Figure 7. Signal ***A*** is a 1 MHz periodic signal.

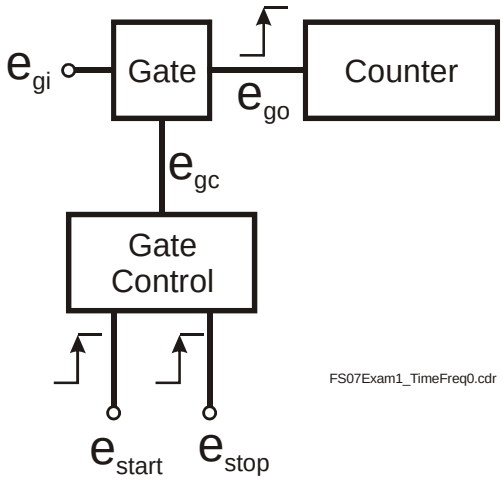

Figure 7

FS07Exam1_TimeFreq1.cdr

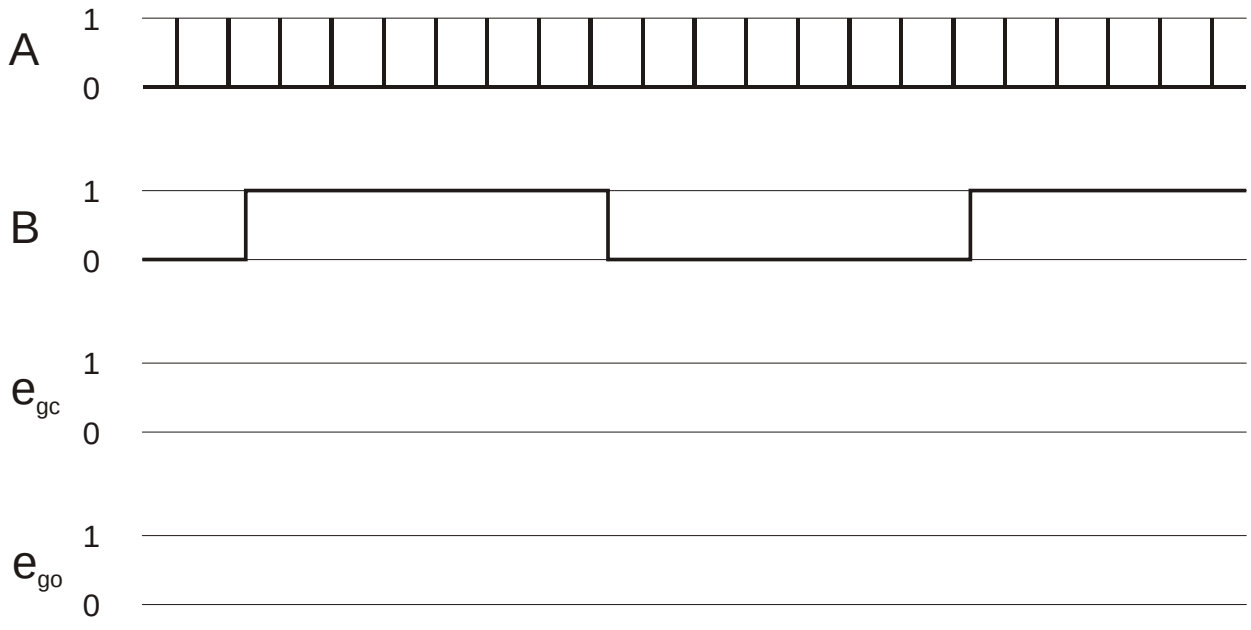

Figure 8 - Signal Timings

Question 8 Time and Frequency

a.) (2 points) Where would you connect Signal **A** to the circuit in Figure 7?

b.) (2 points) Where would you connect Signal **B** to the circuit in Figure 7?

c.) (3 points) In the space provided in Figure 8, sketch the time course for $\mathbf{e_{gc}}$ that would result.

d.) (3 points) In the space provided in Figure 8, sketch the time course for $\mathbf{e_{go}}$ that would result.

e.) (5 points) What would be the contents of the counter at the end of one cycle of Signal ***B***. What can you say about Signal **B**?

Question 9 Logic

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Figure 9 illustrates a simple shift register. Figure 10 shows the time behavior of two of the control signals for the shift register. The signals ***Left Out/Right In***, ***Right Out/Left In***, and ***Load*** are disconnected. The first row of Table 1 contains the initial contents of the shift register.

Complete Table 1 by entering the contents of the shift register at the indicated times, t_i.

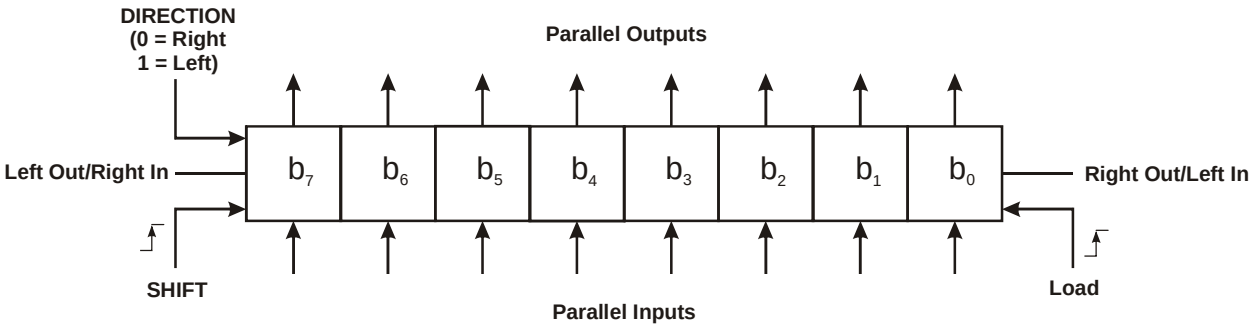

Figure 9

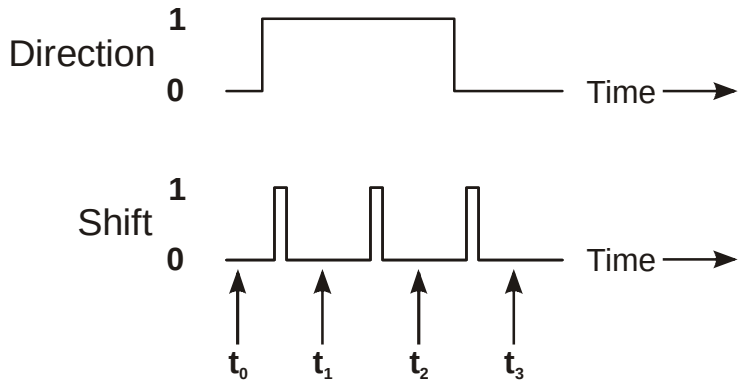

Figure 10

Table 1

Time	b_7	b_6	b_5	b_4	b_3	b_2	b_1	b_0
t_0	1	1	0	1	1	0	1	1
t_1								
t_2								
t_3								