Name : _____   Section:_____   CWRU e-mail:_____

Department of Electrical Engineering and Computer Science
ENGR 210. Introduction to Circuits and Instruments (4)
ENGR 210 - SPRING 2004

FINAL EXAMINATION– given 5/4/03

		Possible	
1.		10	DC OP AMPS
2.		10	Controlled sources
3.		10	Equivalent circuits
4.		10	Maximum power transfer
5.		10	Capacitors and inductors
6.		10	Phasor circuit analysis
7.		10	Transfer function (OP AMP)
8.		10	Passive transfer function/Bode plot
9.		10	Complex transient
10.		10	Switched transient
SCORE		100	

ACADEMIC DISHONESTY
All forms of academic dishonesty including cheating, plagiarism, misrepresentation, and obstruction are violations of academic integrity standards. Cheating includes copying from another's work, falsifying problem solutions, or using unauthorized sources, notes or computer programs. Misrepresentation includes forgery of official academic documents, the presentation of altered or falsified documents or testimony to a university office or official, taking an exam for another student, or lying about personal circumstances to postpone tests or assignments. Obstruction occurs when a student engages in unreasonable conduct that interferes with another's ability to conduct scholarly activity.
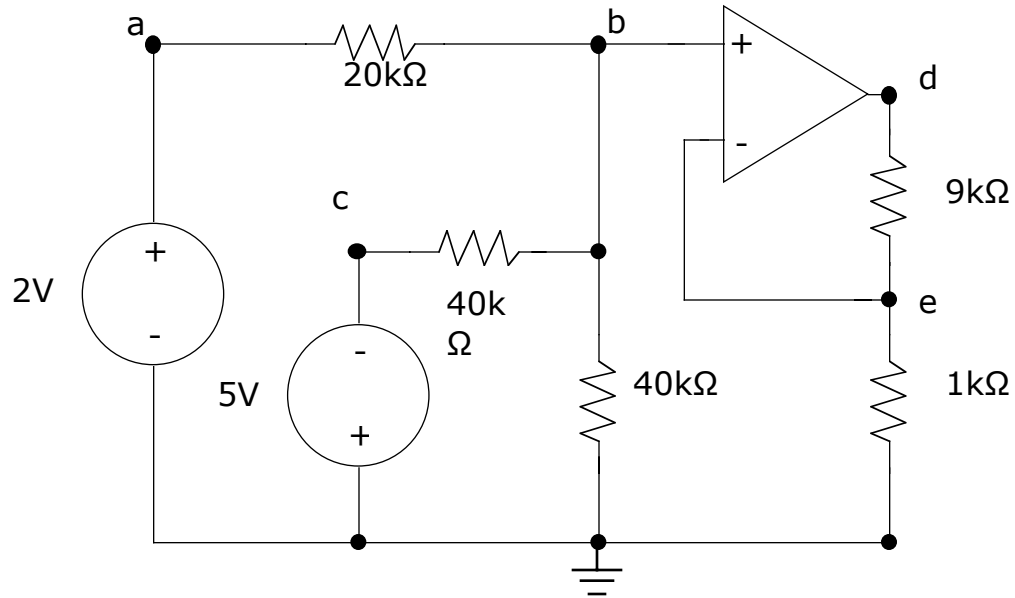
Problem 1 DC OP AMPs (10 points)
Determine the node voltages V_a, V_b, V_c, V_d, and V_e (with respect to ground) for the following OP AMP circuit.   Assume the OP AMP is ideal.
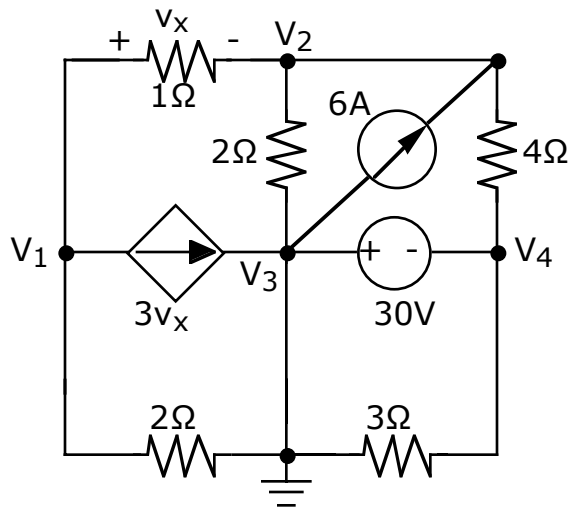
Problem 2 Circuits with controlled sources (10 points)

Find the node voltages V_1, V_2, V_3 and V_4.

Problem 3 Equivalent Circuits (10 points)
You measure the output voltage of a new fuel cell under a variety of different loads. You plot the data and fit a curve to the data getting the equation $V = 13.45 \quad 53.84i$.
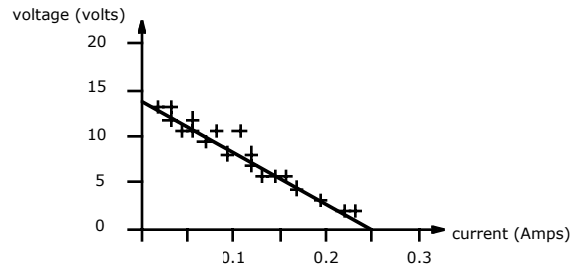
You need an electrical model for this fuel cell to be included in a report to your supervisor.

(a) What is the Thevenin voltage VT for this fuel cell?

(b) What is the Thevenin resistance RT for this fuel cell?

(c) Draw a Thevenin equivalent circuit for this fuel cell.

**Problem 4 Maximum power transfer** (10 points)
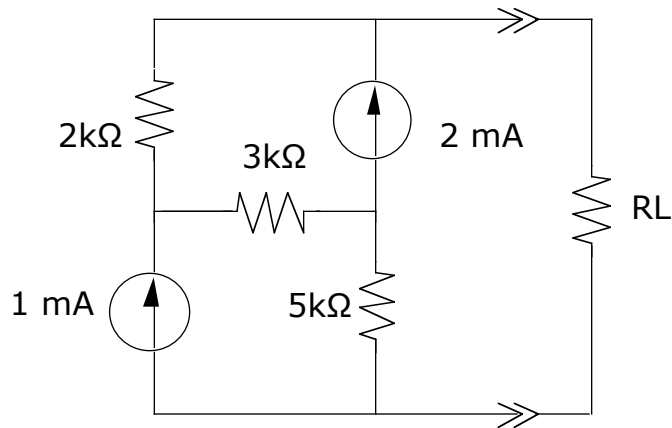

Consider the above circuit.

(a) What is the open circuit voltage, i.e., if $R_L = \infty$?

(b) What is the Thevenin resistance of this circuit to the left of R_L?

(c) What is the maximum power that can be dissipated by R_L?

(d) At what value of R_L does this maximum power dissipation occur?

Problem 5 Capacitors and Inductors (10 points)

(a) A particular element is tested and found to have i(t) and v(t) as shown here. Identify the type of element and its value.

i(t), Amps

10

5

0

0.5   1.0   1.5

t, seconds

v(t), Volts

0.10

0.05

0

0.5   1.0   1.5
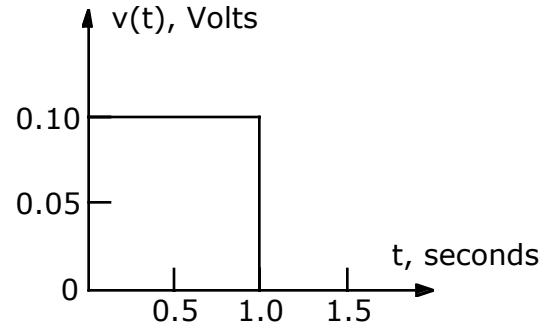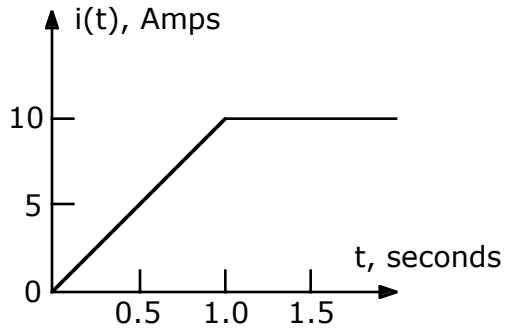
t, seconds

(b) A second element is tested and found to have i(t) and v(t) as shown below. Identify the type of element and its value.

i(t), mA

2.5

0

1   2   3   4

-2.5

t, mS

v(t), Volts

10

5

0

1   2   3   4

t, mS
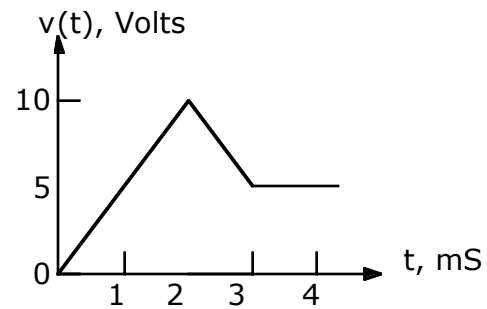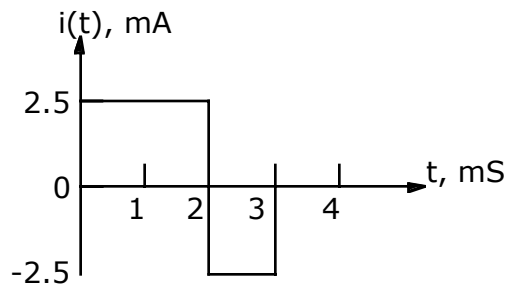
Problem 6 Phasor circuit analysis (10 points)

The following circuit is a very simple model of a power system delivering power to a small factory.   If Vs=1000cos(400t) answer the following questions.

L=0.25H

Vs   R₁=500Ω   C=25µf   R_L   Vo
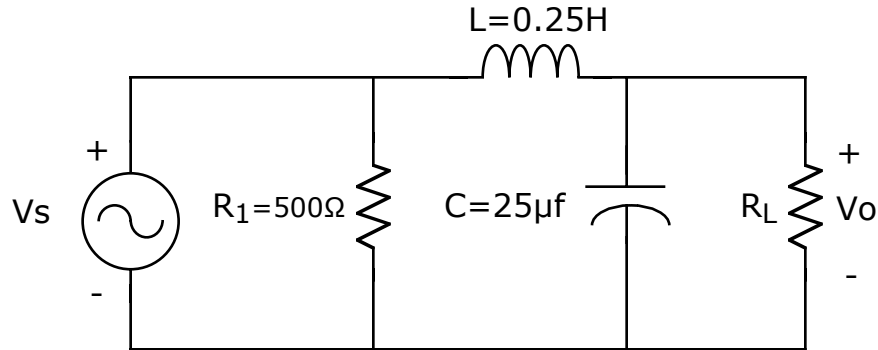
a) What is the frequency (in Hertz) at which this power system is operating?

b) What is the impedance of the inductor and the capacitor.

c) For $R_L=100\Omega$, determine the complex voltage Vo appearing across R_L. Write the value of this complex voltage using *a+jb*   notation.

What is the corresponding real voltage, i.e. represented as a sinusoidal function?

d) At night the plant manager turns off some of the plant equipment to save money.   This increases the equivalent load to $R_L=1000\Omega$.   For $R_L=1000\Omega$, determine the complex voltage Vo appearing across R_L. Write the value of this complex voltage using *a+jb*   notation.

What is the corresponding real voltage, i.e. represented as a sinusoidal function?

e)   (OPTIONAL) The plant equipment starts to fail at night.   Based upon your answers for c) and d) can you suggest why?

Problem 7 Transfer Functions (10 points)
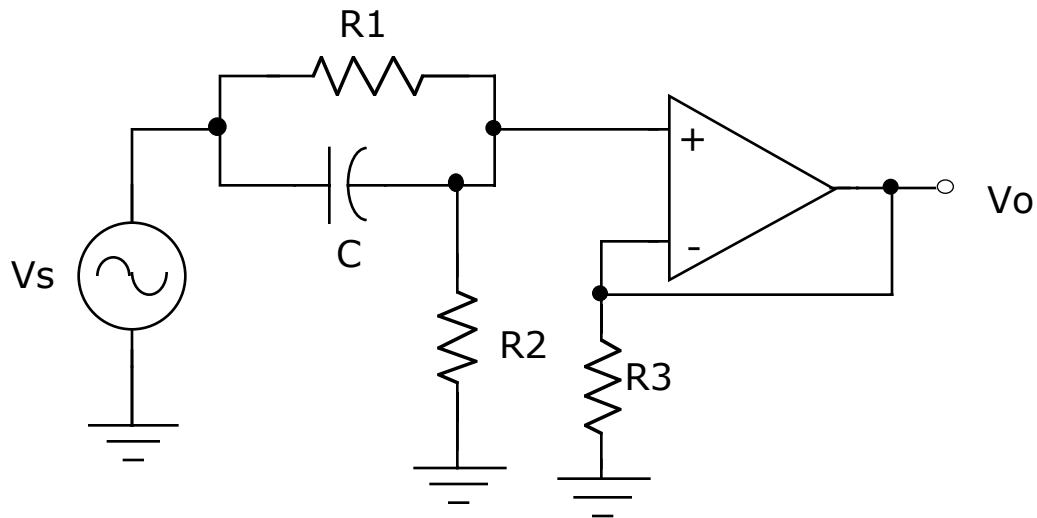
(a) Determine the frequency dependent system transfer function for the OP AMP circuit shown above.

(b) What is the DC gain ($\omega \rightarrow 0$) of this circuit?

(c) What is the high frequency gain ($\omega \rightarrow \infty$) of this circuit?

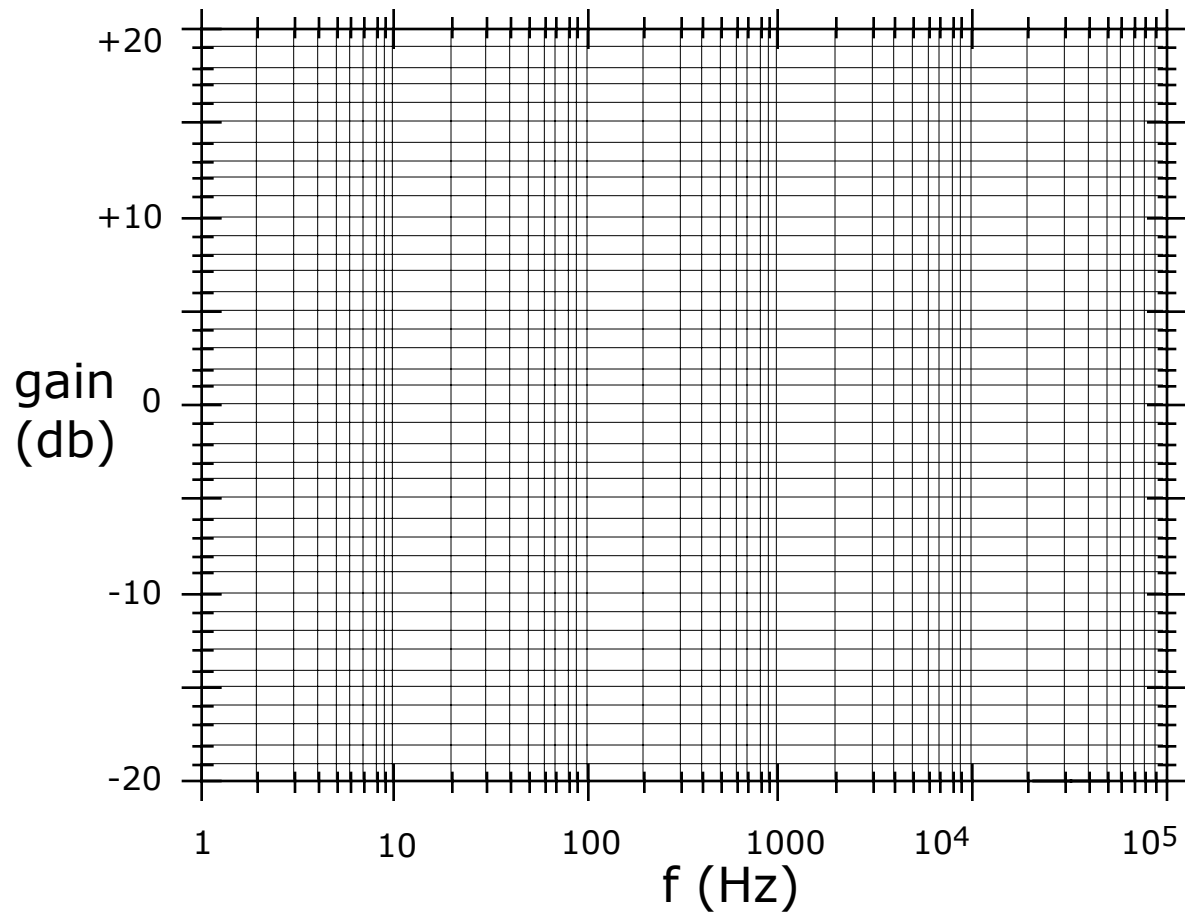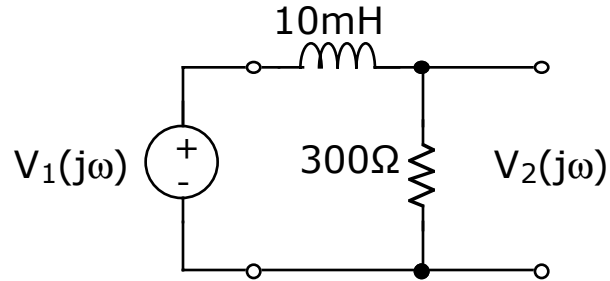(d) What kind of filter function (high pass, low pass, etc.) does this circuit perform?

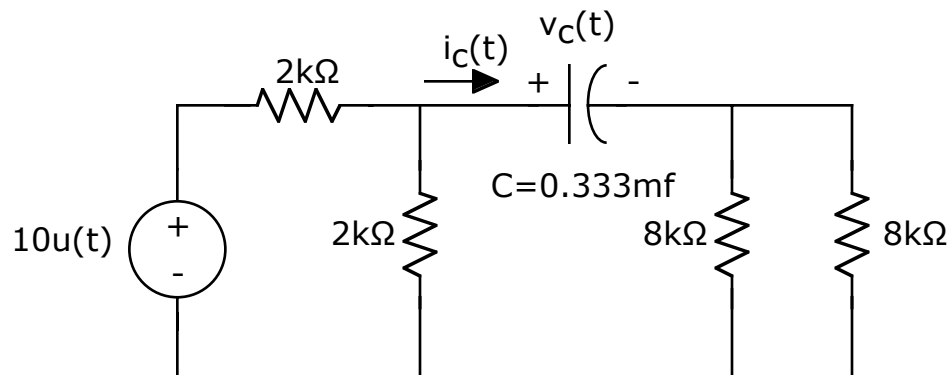**Problem 8 Bode Plots** (10 points)

Determine the transfer function for the circuit shown below. Plot its frequency dependent gain (in db) on the graph below. Note that the horizontal axis is f.

Problem 9 Transients (10 points)

For the above time-dependent circuit:

a) What is the state variable in this circuit?

b) Write the differential equation that describes the response of $V_c(t)$ to the step input $v_s(t)=10u(t)$.

c) Determine the time dependent behavior of $V_c(t)$ for $v_s(t) = 10u(t)$ V.

d) What is $i_c(t)$?

Problem 10 Switched circuits (10 points)
The switch in the circuit shown below has been in position A for a long time and is moved to position B at t=0.
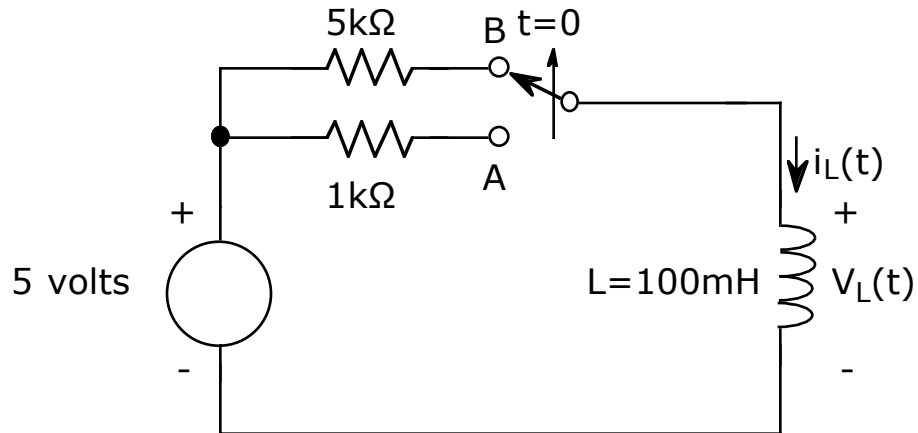
(a) What is $i_L(0)$?

(b) What is $i_L(\infty)$?

(c) What is the time constant of this circuit?

(d) Find $i_L(t)$ for $t \geq 0$.

(e) What part of (d) is the forced response?

(f) What part of (d) is the natural response?