ECE 53a	FINAL EXAM	Prof. Pamela Cosman	3/19/07

First Name: _____

Last Name: _____

This exam has 10 problems. They have point values between 6 and 12 points. The total number of points is 100.

On this exam, you are allowed to use ONE page of notes (both sides of the page).

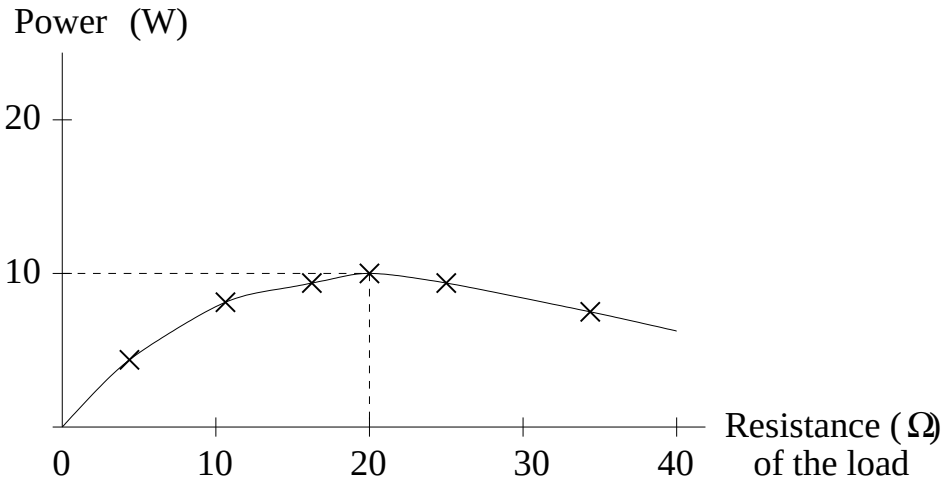
You ARE allowed to use a calculator.

Good luck!

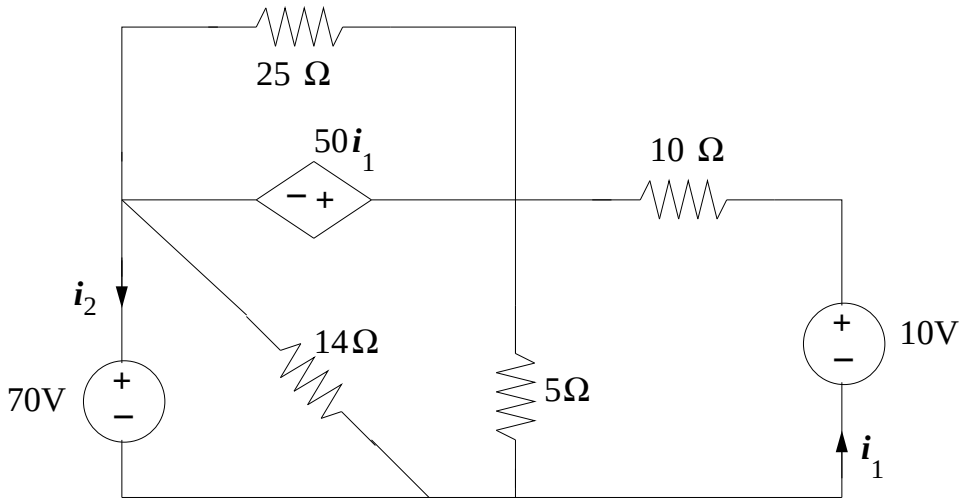
SCORING:

Problem	Points obtained	Points possible
1		10
2		10
3		12
4		10
5		12
6		12
7		6
8		10
9		10
10		8
Total		100

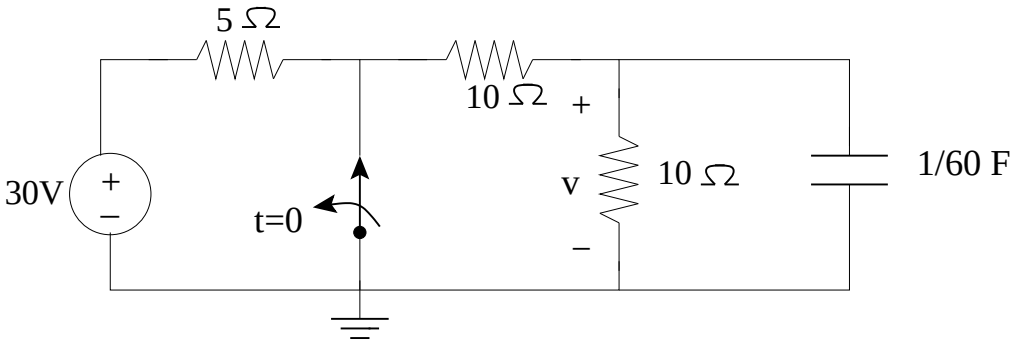
Problem 1: (10 points) A black box with two terminals was connected to a variable resistor and the power in the resistor was measured as the resistance was varied. The results are shown in the following plot. From this graph, determine the Thevenin equivalent circuit for the circuit in the black box. You may assume it is a DC circuit.



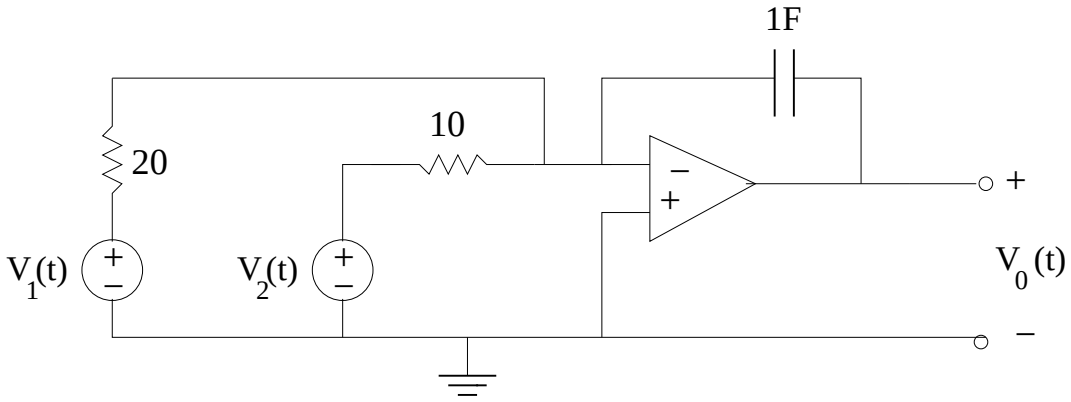
Problem 2: (10 points) Find the values of i_1 and i_2 in the following circuit.



Problem 3: (12 points) In this circuit, the switch is closed for a long time, and then opens at time t=0. (a) Find the indicated voltage v(t) for all time. (b) Consider the current i_c that flows through the capacitor, and consider the current i_R that flows in the resistor in parallel with the capacitor. Is either of these currents (or both, or neither) continuous at time t=0 (i.e., have NO jump discontinuity at time t=0)? Explain how you know. (c) For what times $t_{ss} > 0$ would one typically consider that this circuit is in steady state?



Problem 4: (10 points) In the following circuit, $V_1(t) = 80cos(100t)$ and $V_2(t) = 40cos(100t)$. Find the output voltage $V_0(t)$. The amplifier is an ideal op amp.



Problem 5: (12 points)

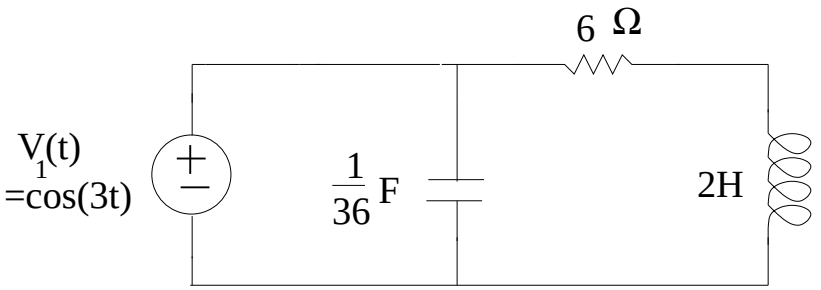
(a) The resonance frequency of the following circuit is $\omega_r = 3$ rad/sec. Write down an expression that would show how the resonance frequency is obtained. You do not have to carry out the algebraic steps to get there; just show the initial expression.

(b) What is the energy stored by the inductor as a function of time?

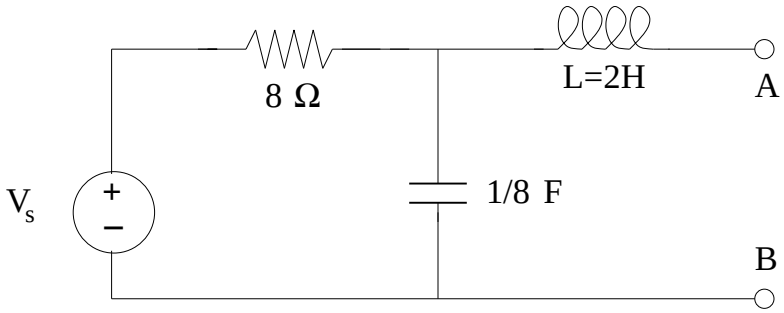
(c) What is the energy stored by the capacitor as a function of time?

(d) What is the energy dissipated by the resistor in one period?

(e) Write down an expression for the quality factor of the circuit in terms of your answers to the previous parts. Again, you do not have to carry out the algebra.

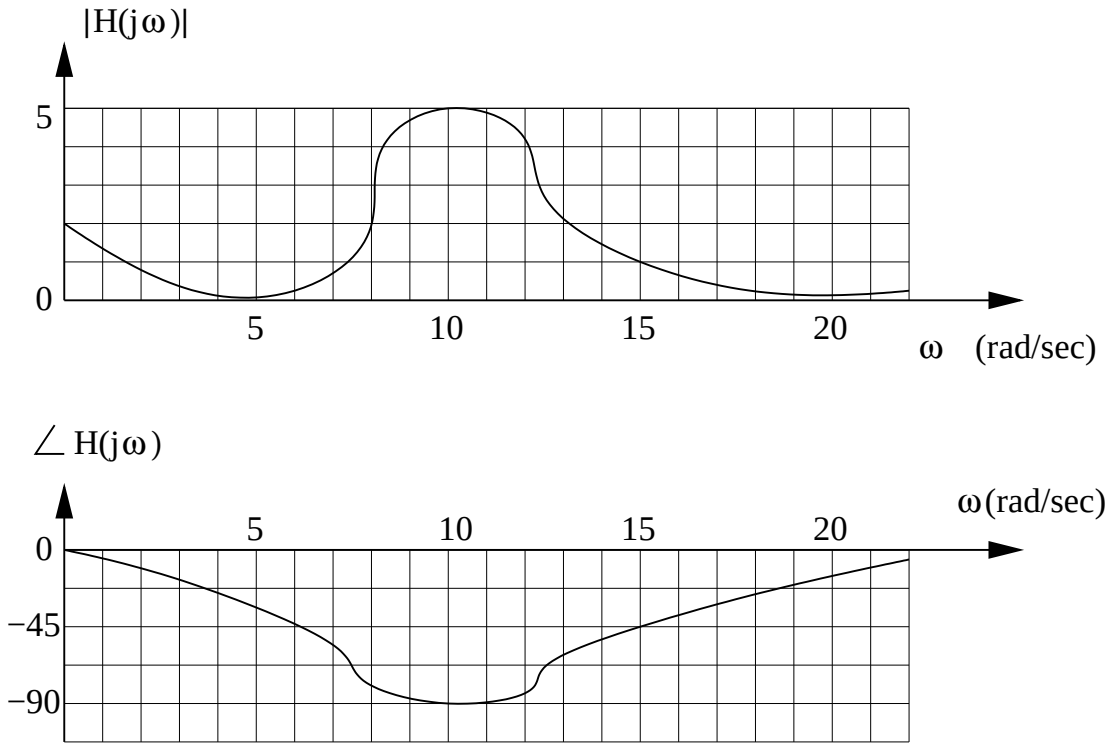


Problem 6: (12 points) In the following circuit, $V_s(t) = 10\cos(4t)$.
(a) Find the Thevenin equivalent of the following circuit to the left of the terminals A-B.
(b) Which load impedance Z_L would absorb the maximum average power?
(c) Determine this maximum power.
(d) Which load resistor R_L would absorb the maximum power for resistive loads?



Problem 7: (6 points) A hypothetical circuit has the frequency response characteristics shown below. The magnitude and phase of the transfer function are plotted. The input to the circuit is $V_s(t) = 10 + 3\cos(5t) + 7\sin(10t) + 4\cos(15t + 30^o)$

If it is possible to find the steady-state output for this input, then find it. If it is not possible to find it from the information given, then explain why not.



Problem 8: (10 points) (a) Use only straight-line asymptotes to sketch the Bode plot (amplitude response only) for the transfer function

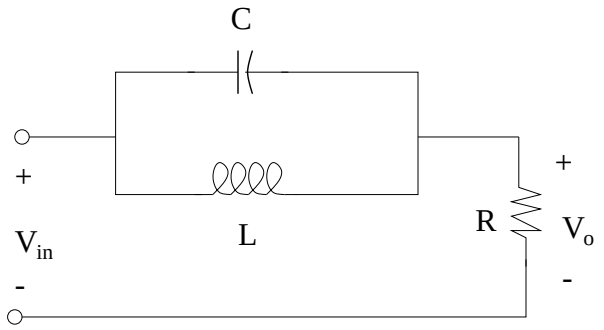
$$H(j\omega) = \frac{j\omega}{10 + 11j\omega + (j\omega)^2}$$

Note that

$$10 + 11j\omega + (j\omega)^2 = (1 + j\omega)(10 + j\omega)$$

(b) What kind of filter is this?

Problem 9: (10 points) The following circuit can be used as a bandstop filter.



(a) Write the voltage transfer function $H(j\omega) = V_o/V_{in}$.
(b) Explain how you can tell from the transfer function that it is a bandstop filter.
(c) We want to use this filter to remove an annoying 60-Hz hum that is present in the input. You have access to a capacitor that is 10μF. What value of L and/or R do you need to satisfy this goal?

Problem 10: (8 points) In the following circuit, $V_s(t) = 120\sqrt{2}\cos(120\pi t)$ Volts.
The design goal is to have i(t) lead $V_s(t)$ by 55^o.
(a) What is in the box: R, L, or C?
(b) What is its numerical value?