EECS 40, Fall 2006
Prof. Chang-Hasnain
Midterm #2

October 25, 2006
Total Time Allotted: 50 minutes
Total Points: 100 / Bonus: 10 pts

1. This is a closed book exam. However, you are allowed to bring one page (8.5" x 11"), single-sided notes PLUS your 1-page notes from midterm 1.
2. No electronic devices, i.e. calculators, cell phones, computers, etc.
3. Slide rules are allowed.
4. SHOW all the steps on the exam. **Answer without steps will be given only a small percentage of credits.** Partial credits will be given if you have proper steps but no final answers.
5. **Remember to put down units.** Points will be taken off for answers without units.

Last (Family) Name:_____

First Name:_____

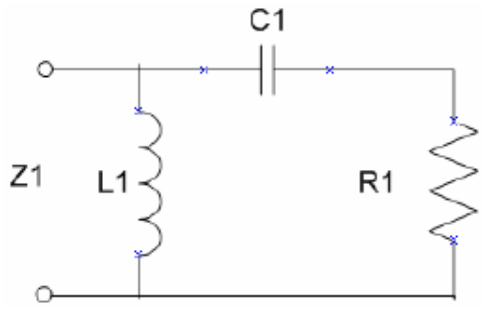
Student ID:_____ Discussion Session:_____

Signature:_____

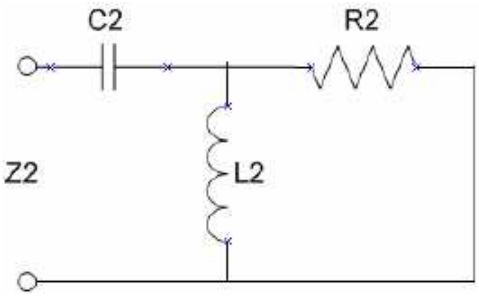
Score:	**110**
Problem 1 (16 pts) Complex Impedances	16
Problem 2 (54 pts): Bode Plots	54
Bonus (10 pts):	10
Problem 3 (30 pts): Second-order Circuits	30
Total	110

1. [16 points] Parallel and Series Complex Impedance

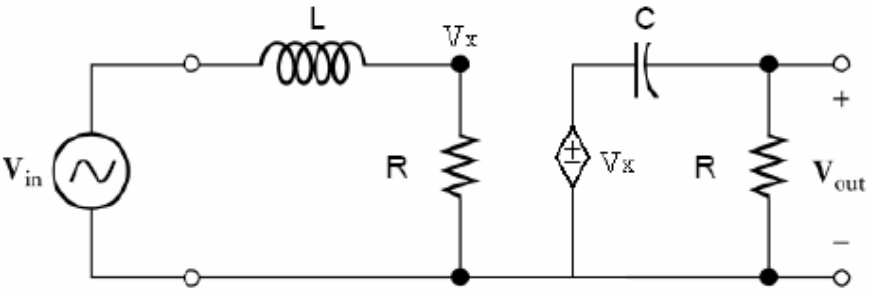
a) [8 pts] What is the complex impedance Z_1?



b) [8 pts] What is the complex impedance Z_2?



2. [54 points] Bode Plots:



(a) [10 points] For the above circuit, show

$$H(f) = \frac{1}{1 + j\frac{f}{f_2}} \times \frac{1}{1 - j\frac{f_1}{f}}$$

Express f_1 and f_2 in terms of R, L, C. (Hint: Remember $\omega = 2\pi f$)

(b) [6 points] Now Let R = 1kΩ, L = 0.16mH, C = 0.16 uF, what are f_1 and f_2? Remember to put down units.

(**c) [22 pt] Bode Magnitude Plot.** ***You must put down all the steps leading to your results.***
Hint: You may consider $f_1 << f_2$

[4 points] Write down the expression for $y = 10\log|H(f)|^2$

[4 points] As frequency goes to a very small value, what is the slope of y as a function of log f ?

[4 points] As frequency goes to a very large value, what is the slope of y as a function of log f ?

[4 points] What is y, $f_1 << f << f_2$?

[2 points] What is y at f_1?

[2 points] What is y at f_2?

[2 points] What filter is this?

Bonus [5 points] If the input $|V_{in}|$ = 1 V and the frequency is 1 MHz, what is the output $|V_{out}|$?

Bonus [5 points] If the input $|V_{in}|$ = 1 V and the frequency is 10 MHz, what is the output $|V_{out}|$?

(d) [16 pt total] Bode Phase Plot. ***You must put down all the steps leading to your results. Hint: You may consider*** $f_1 << f_2$
[4 points] Write down the expression for $\angle H(f)$

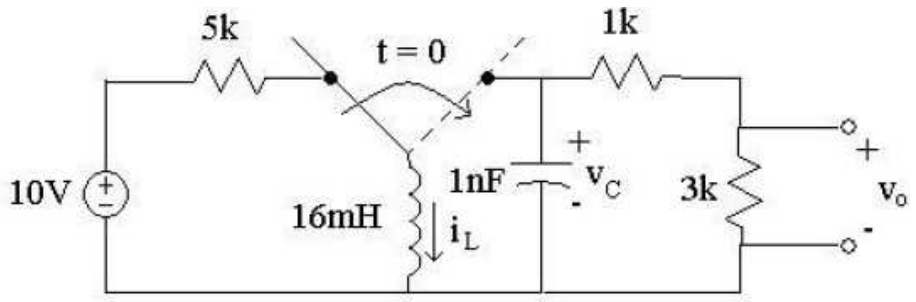
[4 points] What does the value of $\angle H(f)$ approaches to as $f \rightarrow 0$?

[4 points] What does the value of $\angle H(f)$ approaches to as $f \rightarrow \infty$?

[2 points] What is $\angle H(f)$ *at* $f = f_1$?

[2 points] What is $\angle H(f)$ *at* $f = f_2$?

3. [30 points] Second-order Circuits:



Assume the switch has been to the left for a long time before switching to the right at t = 0.

(a) Find the following values: [18 points] (Hint: What is $V_0(t)$ in terms of $V_c(t)$?)

$i_L(0+) =$	$i_L(\infty) =$
$v_C(0+) =$	$v_C(\infty) =$
$v_o(0+) =$	$v_o(\infty) =$
$\frac{d}{dt} i_L(0+) =$	
$\frac{d}{dt} v_C(0+) =$	
$\frac{d}{dt} v_o(0+) =$	

(b) [6 points] Write the differential equation in terms of v_C.

(c) [6 points] What are the values of the natural frequency (ω_0) and the damping ratio (ζ)?