ECSE 2010
Electric Circuits
Exam 3
Spring 2008

Name Solutions - Dr

Section (please circle one)

10-11 11-12

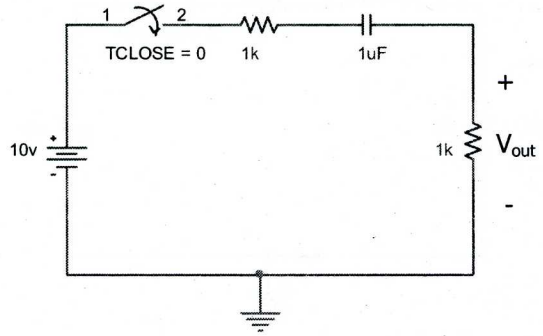
Problem No.	Pts.	Score
1	20pts	
2	30pts	
3	10pts	
4	25pts	
5	15pts	
Total	100pts	

Please Note:

- All your answers must be placed in the spaces provided.
- You MUST show your work to receive any credit.
- Assume ALL sources are turned ON at t=0, unless noted otherwise.
- **The Laplace transform of 10u(t) = 10/s.**

Problem 1 (20pts)

a.) The switch is open for a long time before closing at t = 1ms in the circuit shown below. Find $V_{out}(s)$ for $t \geq 1ms$ and sketch $V_{out}(t)$ for $t \geq 0$. (10pts)



$V_{in}(s) = \frac{10}{s}$ $\quad V_{OUT} = V_{oss} + (V_{o,IN} - V_{oss})\, e^{-t/\tau}$

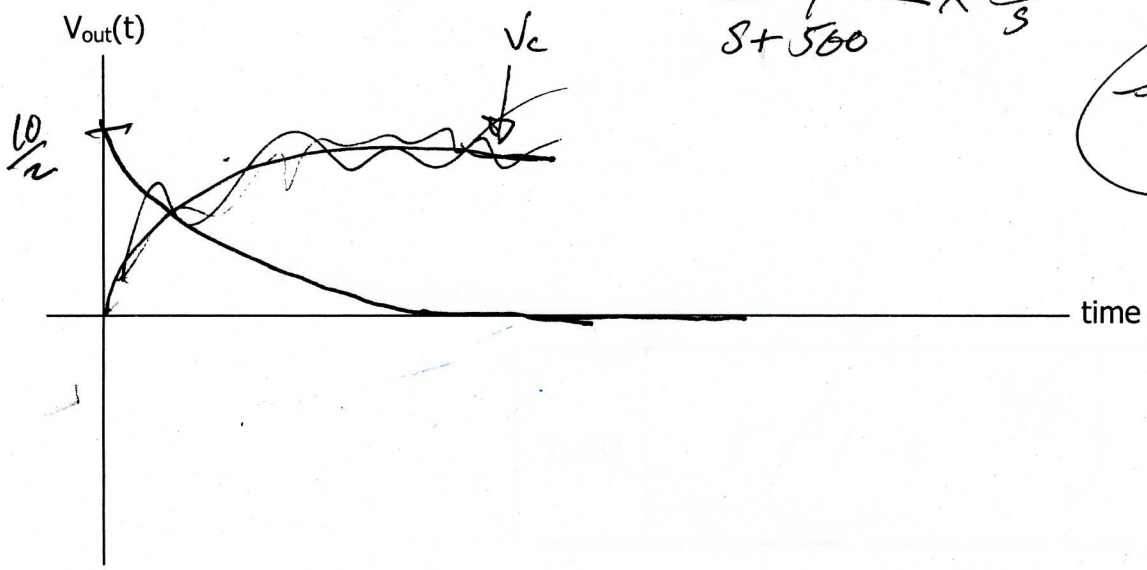
$V_o(s) = \dfrac{1K}{2K + \frac{1}{sC}} \cdot \dfrac{\frac{s}{2K}}{\frac{s}{2K}}$

$V_o(s) = \dfrac{\frac{s}{2}}{s + \frac{1}{2KC}}$

$V_{out}(s)$	$\dfrac{s/2}{s + \frac{1}{2KC}} \times \dfrac{10}{s}$

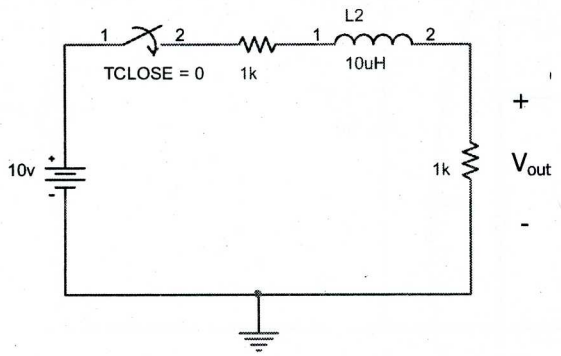
$\dfrac{s/2}{s+500} \times \dfrac{10}{s}$

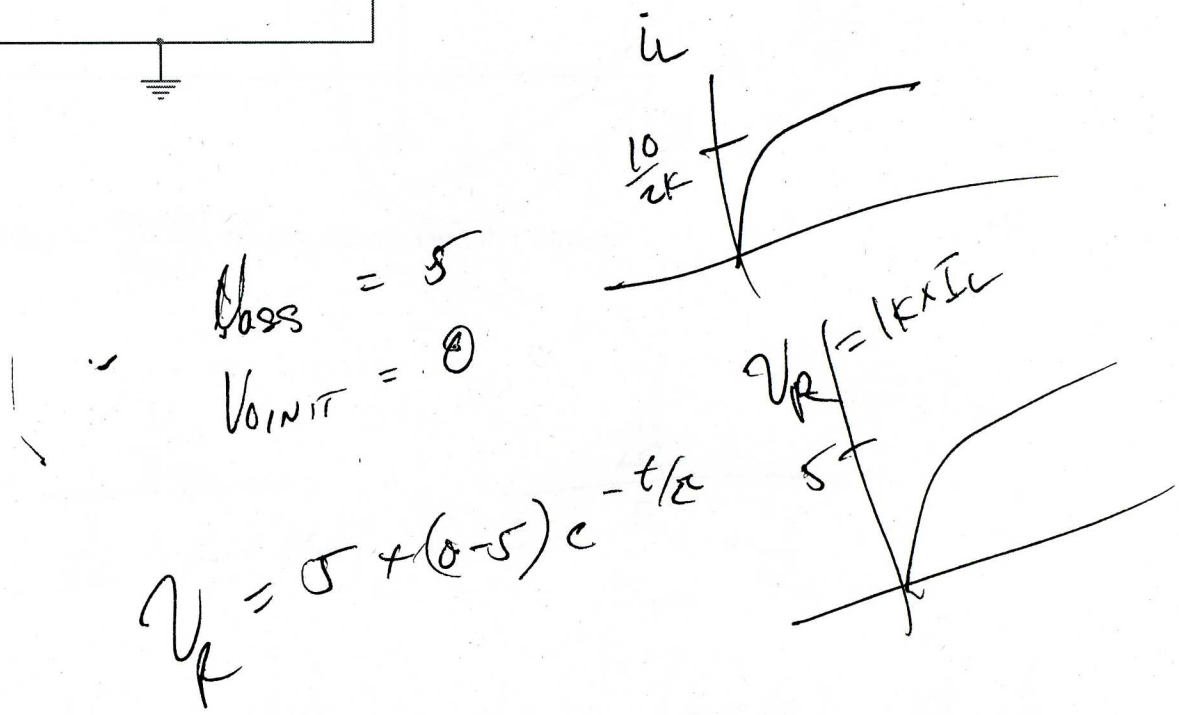
$= \dfrac{5}{s+500}$



Problem 1 (cont)

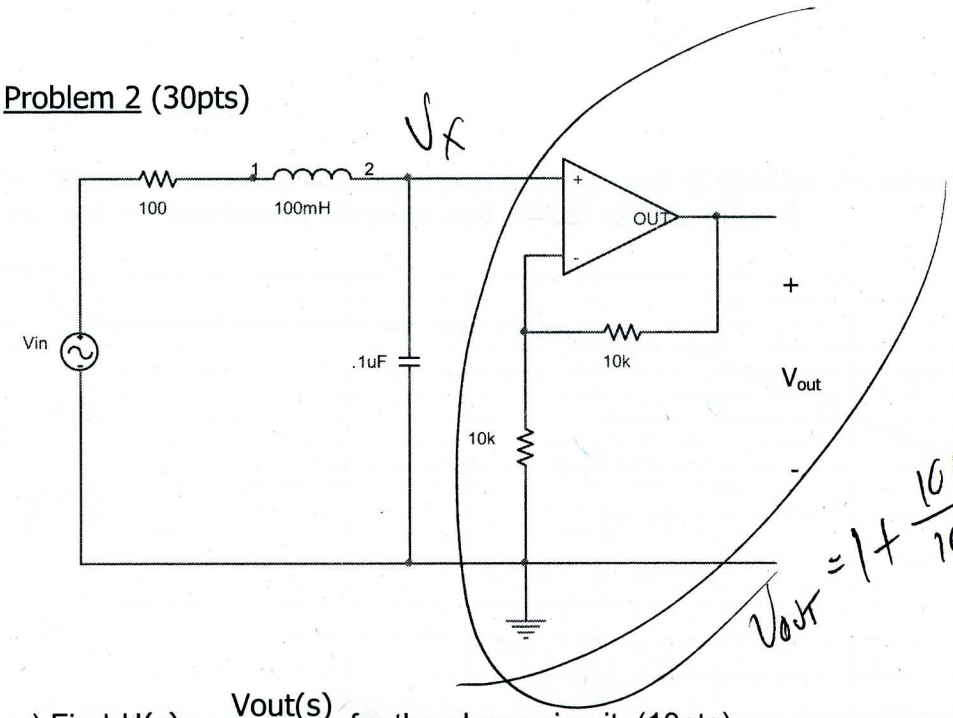
b.) Find $V_{out}(t)$ for $t \geq 0$ given the circuit shown below, showing all pertinent values. (10pts) NOTE THIS IS A DIFFERENT CIRCUIT THAN PART A.





$V_{out}(t)$	$5\left(1 - e^{-t/\tau}\right)$

Problem 2 (30pts)



$V_{OUT} = 1 + \frac{10K}{10K} = 2V_x$

a.) Find H(s) = $\frac{Vout(s)}{Vin(s)}$ for the above circuit. (10pts)

$$\frac{V_x}{V_{IN}} = \frac{\frac{1}{sC}}{\frac{1}{sC} + R + sL} = \frac{\frac{1}{LC}}{s^2 + \frac{R}{L}s + \frac{1}{LC}}$$

$$V_{OUT} = 2V_x \; ; \; H(s) = \frac{V_{OUT}(s)}{V_{IN}(s)} = \frac{2\frac{1}{LC}}{s^2 + \frac{R}{L}s + \frac{1}{LC}}$$

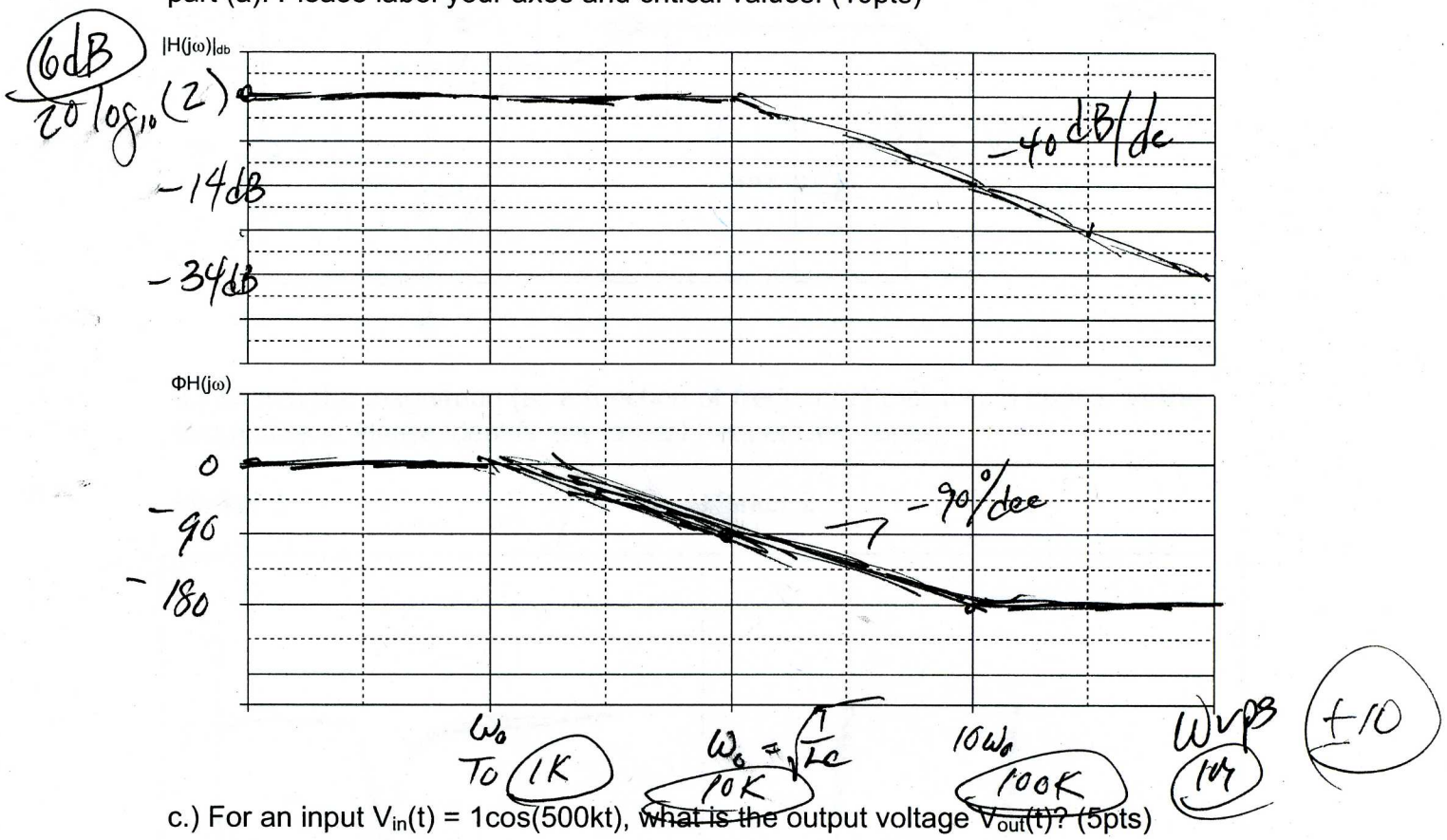
H (s)	$\frac{2\frac{1}{LC}}{s^2 + \frac{R}{L}s + \frac{1}{LC}}$

10pts

$$\frac{2(10{,}000)^2}{s^2 + 1000s + (10{,}000)^2}$$

Problem 2 (cont)

b.) Sketch the asymptotic Bode plot $|H(j\omega)|_{dB}$ and $\Phi H(j\omega)$ for the circuit shown in part (a). Please label your axes and critical values. (10pts)



c.) For an input $V_{in}(t) = 1\cos(500kt)$, ~~what is the output voltage $V_{out}(t)$?~~ (5pts)

$|H(j500K)| \sim .06$

$\angle H(j500K) = -180$

+2 +1 +2

$V_{out}(t)$	$.06\cos(500kt - 180°)$

±5

d.) For an input $V_{in}(t) = 1\cos(1kt)$, what is the output voltage $V_{out}(t)$? (5pts)

$|H(j1K)| = 2$

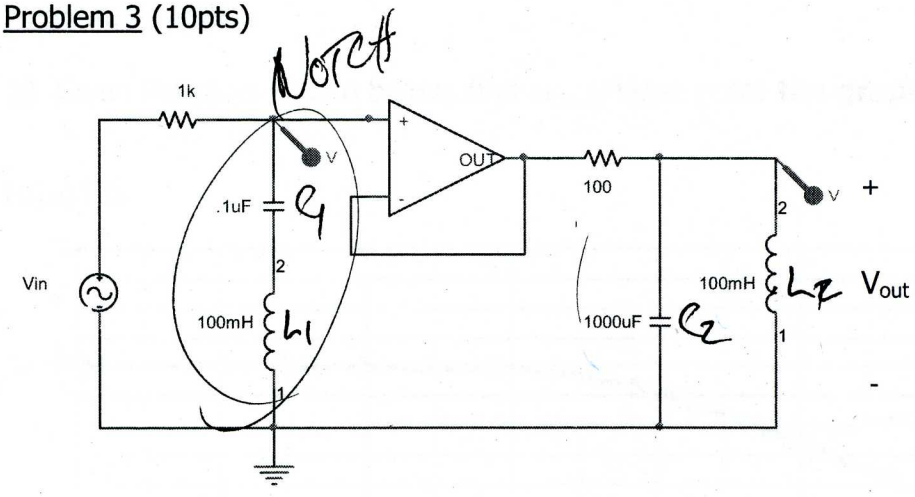
$\angle H(j\,\text{[illegible]}K) = 0$

+2 +1 +2

$V_{out}(t)$	$2\cos(\text{[illegible]}kt)$

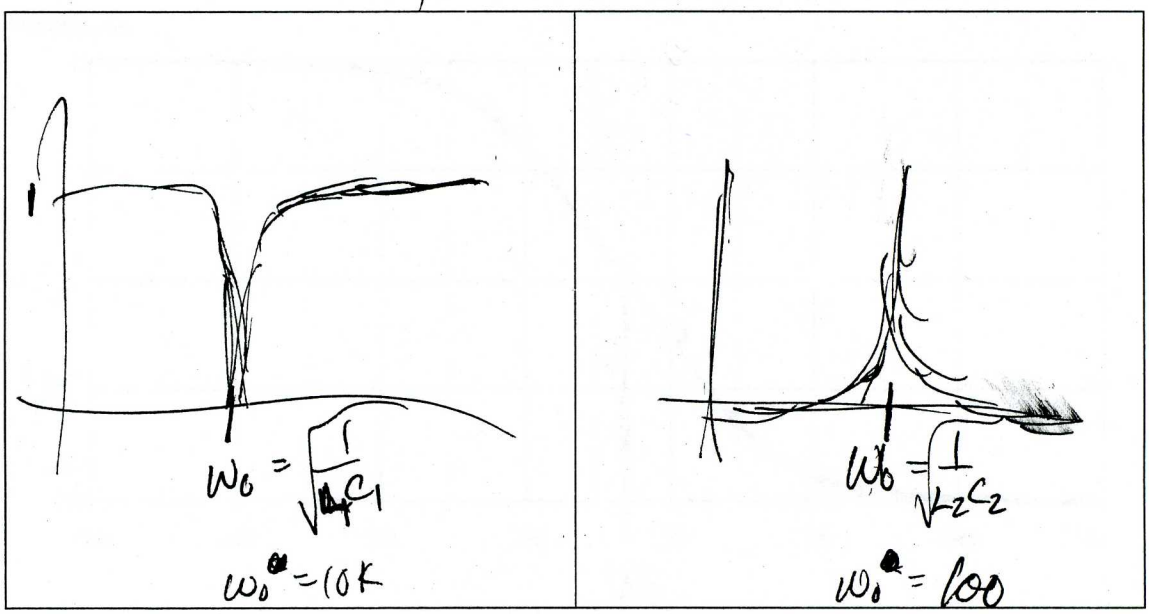
±5

Problem 3 (10pts)



a.) Sketch the magnitude (as a function of frequency) that would appear at the two markers. Please identify any critical frequencies. (6pts)

Marker 1 Marker 2



b.) What is $V_{out}(t)$ for $V_{in}(t) = 1\cos(\omega_0 t)$, where ω_0 is the resonant frequency? Please justify your response. (4pts)

If it is ω_0 for #1 → then $V_{OUT} = 0$

If it is ω_0 for #2 then $V_{OUT} = V_{in}$

$\omega_{0_1}^2 =$

$\omega_{0_2}^2 = 10K$