Midterm 2
EE40
Spring 2013

NAME:_______________________________________

Instructions

Read all of the instructions and all of the questions before beginning the exam.

There are 4 problems in this exam. The total score is 100 points. Points are given next to each problem to help you allocate time. Do not spend all your time on one problem.

Unless otherwise noted on a particular problem, you must show your work in the space provided, on the back of the exam pages or in the extra pages provided at the back of the exam.

Please put the answers into the boxes provided.

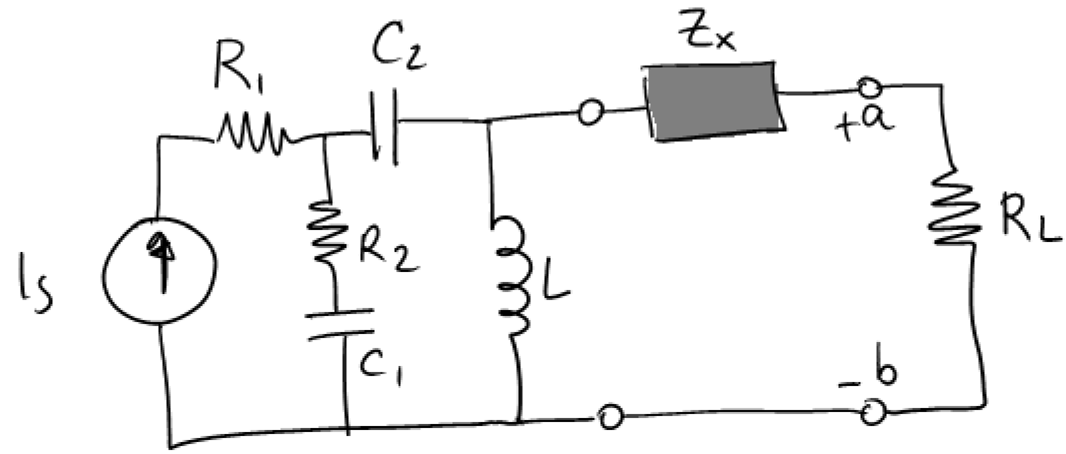
Be sure to provide units where necessary.

GOOD LUCK!

PROBLEM	POINTS	MAX
1		20
2		25
3		30
4		25

Donnie: Why do you wear that stupid bunny suit?
Frank: Why are you wearing that stupid man suit?
- Donnie Darko

Problem 1 *Warm-up* (20 points)
Consider the circuit below.



a) Find a Z_x such that the impedance seen by R_L is purely real *(15 points)*.

$$\mathbf{I_s = \cos(10^6 t)\ A,\ R_1 = 1\ M\Omega\ ,\ C_1 = 1\ \mu F,\ C_2 = 1\ \mu F,\ L = 1\ \mu H}$$

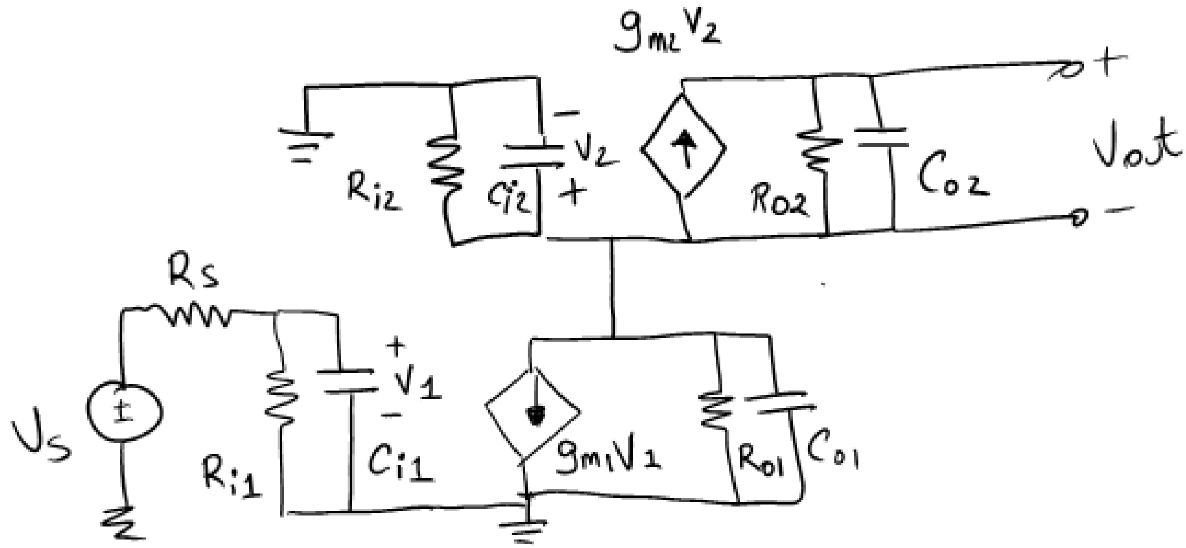
Solution:

b) For a few more points (not many, so relax), find a Z_x such that there is maximum power transfer between R_L and everything to the left of terminals a,b *(5 points)*.

Solution:

“They were watching, out there past men's knowing, where stars are drowning and whales ferry their vast souls through the black and seamless sea.”
— Blood Meridian, or the Evening Redness in the West (*Cormac McCarthy*)

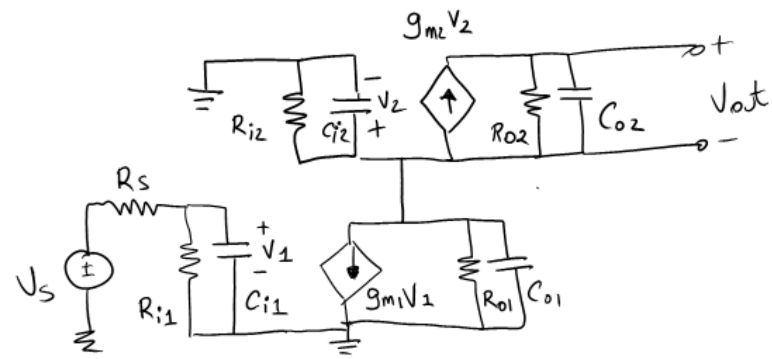
Problem 2 *Transfer functions* (25 points)
Consider the circuit below.



Assume $v_S(t) = v_S cos(\omega t)$

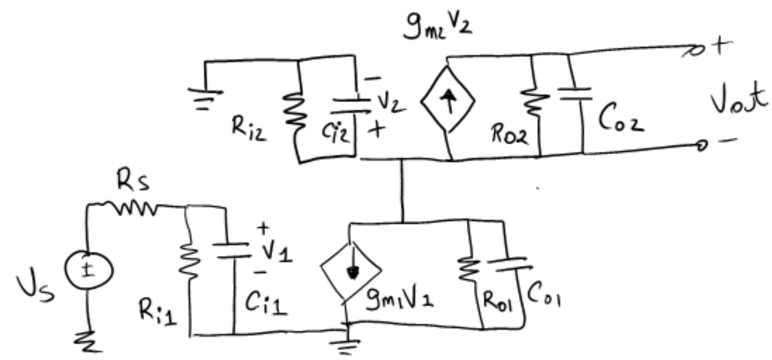
a) Find an expression for $\frac{V_1(\omega)}{V_S(\omega)}$ *(5 points)*

Solution:



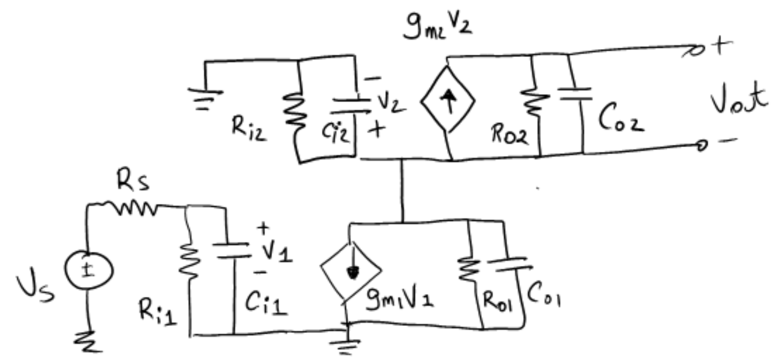
b) Find an expression for $\dfrac{V_2(\omega)}{V_1(\omega)}$ *(10 points)*

Solution:



c) Find an expression for $\dfrac{V_{out}(\omega)}{V_2(\omega)}$ *(5 points)*

Solution:



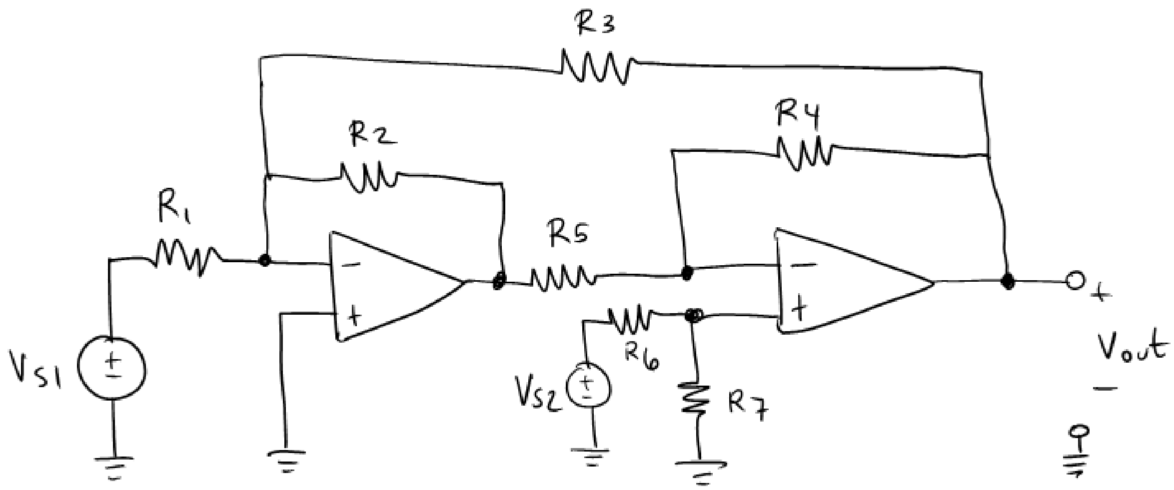
d) Find an expression for $\dfrac{V_{out}(\omega)}{V_S(\omega)}$ *(5 points)*

Solution:

Extra Space

"Put it up to eleven."
- *Marty DiBergi*, **Spinal Tap**

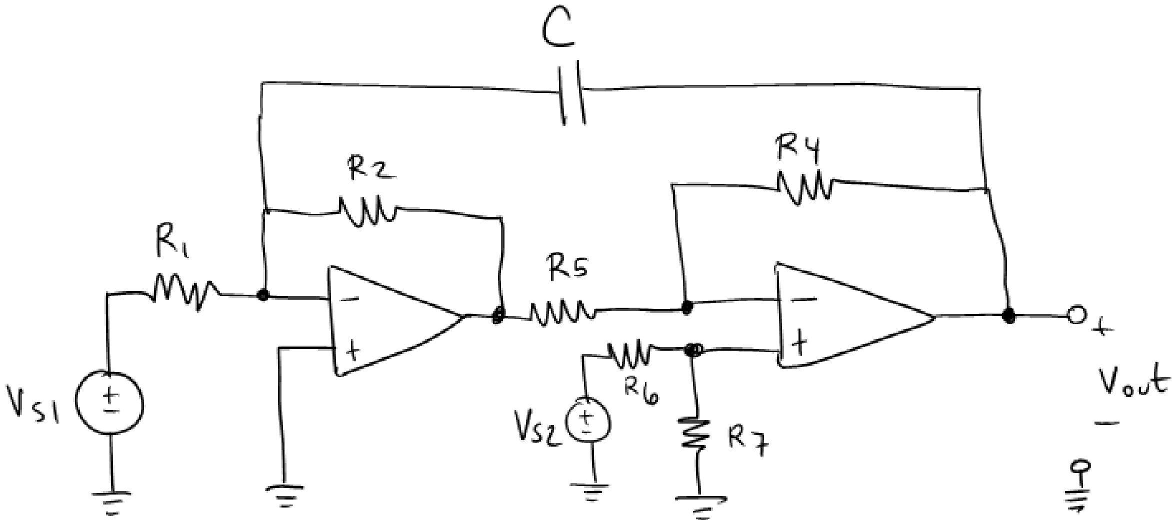
Problem 3 *The Works* (30 points)
Consider the following circuit.



a) Find the DC gain $\left(\frac{V_{out}}{V_{S1}}\right)$ of this circuit given $V_{S2} = 0$ *(10 points)*.

Solution:

b) Now consider the following circuit: *(10 points)*



If V_{s2}=0 for all time and V_{s1} = {**1 V** for t<0; **0 V** for t ≥0}, find an expression for $V_{out}(t)$ for t >0?

Solution:

c) For the circuit above find Vout(t) if V_{s2}=0 and Vs1 = cos($2\pi f$ t). (10 points)

All R's are 10 kΩ, C = 1 μF and f = 159 kHz.

Solution:

Extra Space

Extra Space

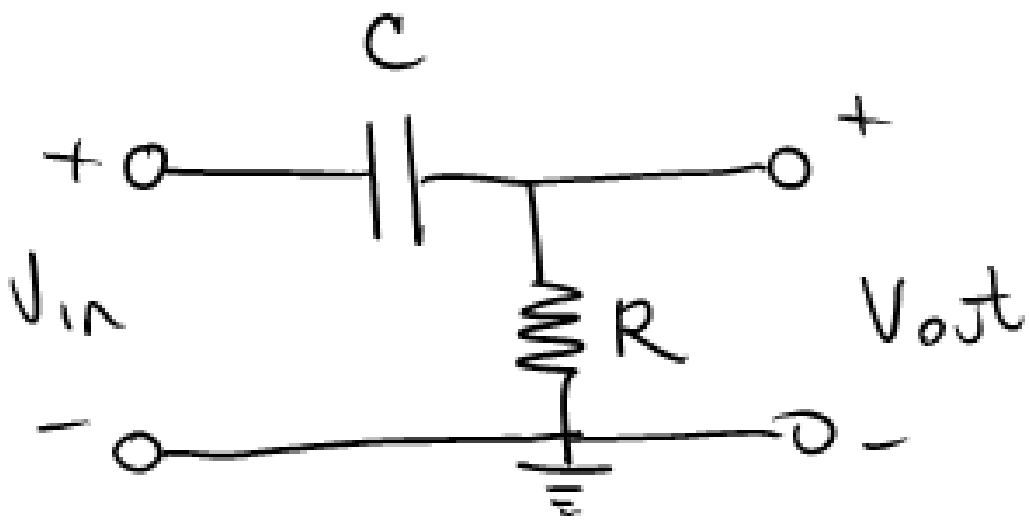
“I've seen things you people wouldn't believe. Attack ships on fire off the shoulder of Orion. I watched c-beams glitter in the dark near the Tannhuser Gate. All those moments will be lost in time, like tears in rain… Time to die.”

- *Roy Batty*, **Blade Runner**

(and by the way these are the greatest dying words ever uttered in sci fi cinema… go watch the movie)

Problem 4 (25 points)

Consider the circuit below. $\mathbf{V_C(0) = 0}$ (i.e. the voltage across the capacitor at t = 0 is 0 volts).
If $V_{in} = u(t)$, what is $V_{out}(t)$?



Solution: