Final
EE40
Fall 2011

NAME:__________________________ SSID:__________________________

Instructions

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

There are 5 problems in this exam. The total score is 130 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.

Draw a BOX or a CIRCLE around your answers to each problem.

Be sure to provide units where necessary.

GOOD LUCK!

PROBLEM	POINTS	MAX
1		25
2		25
3		20
4		35
5		25

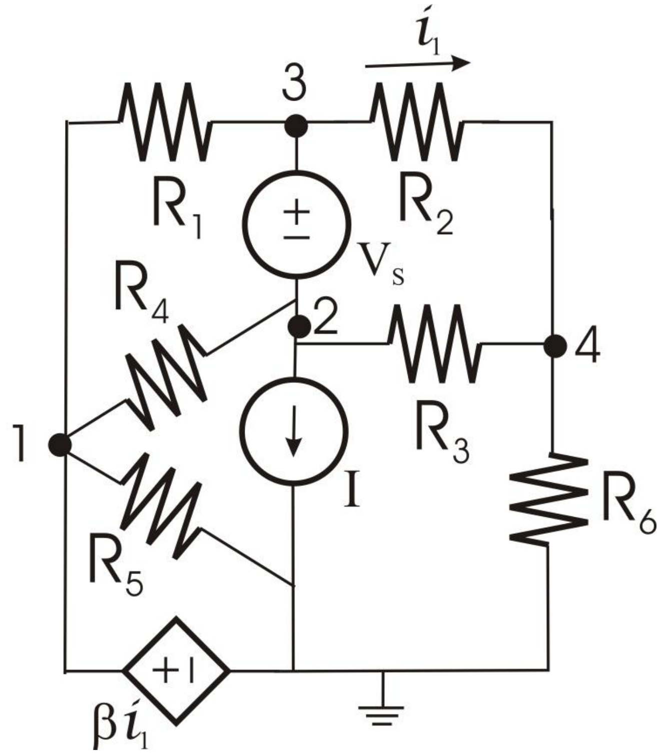
"Failure is always an option"

- Disgruntled CS Guy

(I assume he repeated this so many times to get on the final)

Problem 1 *Warm up (25 points)*

Consider the following circuit:



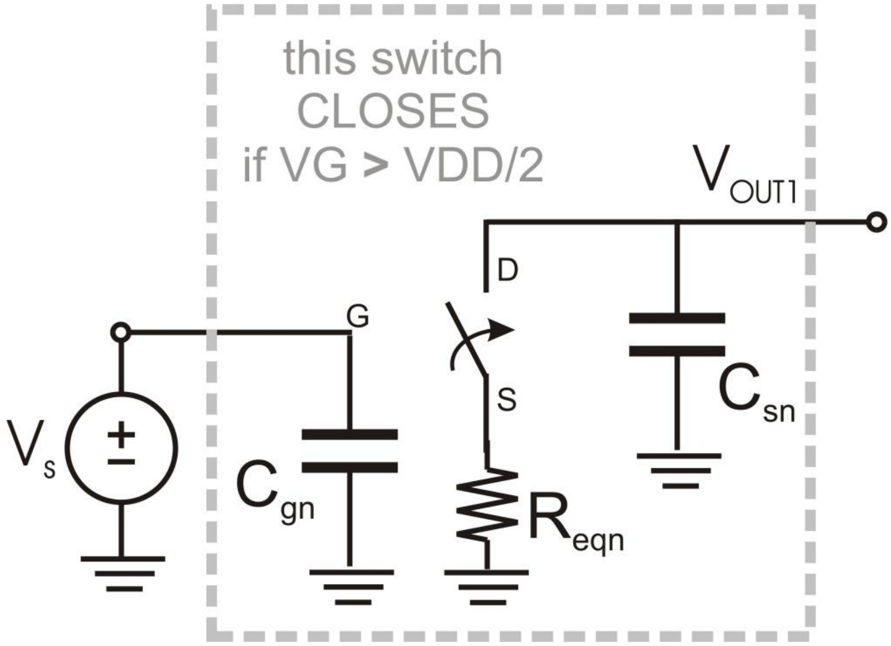
In the box below, provide your answer in this form or ***LOSE POINTS*** *(if there are extra equations, just write them in as well):*

____***v1***	+	____***v2***	+	____***v3***	+	____***v4***	=	____
____***v1***	+	____***v2***	+	____***v3***	+	____***v4***	=	____
____***v1***	+	____***v2***	+	____***v3***	+	____***v4***	=	____
____***v1***	+	____***v2***	+	____***v3***	+	____***v4***	=	____
____***v1***	+	____***v2***	+	____***v3***	+	____***v4***	=	____

Solution:

"Hope is the worst of evils, for it prolongs the torment of man"
-Friedrich Nietzsche

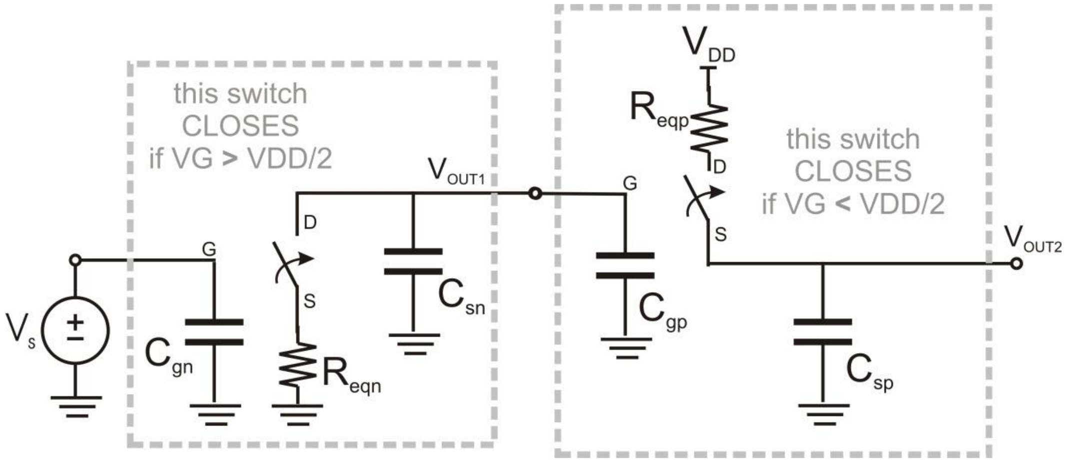
Problem 2 *RC circuits (25 points)*



a) Consider the circuit above. If Vs(t) = V_{DD}*u(t) V provide an expression for V_{OUT1}(t). You can assume $V_{OUT1}(0) = V_{DD}$. *(5 points)*

V_{OUT1}(t) =

b) Now consider the case where we connect the following two modules together:



Notice the first module is the same as that in a) and the second is very similar.
Notice the two switches close on ***different*** *conditions!*

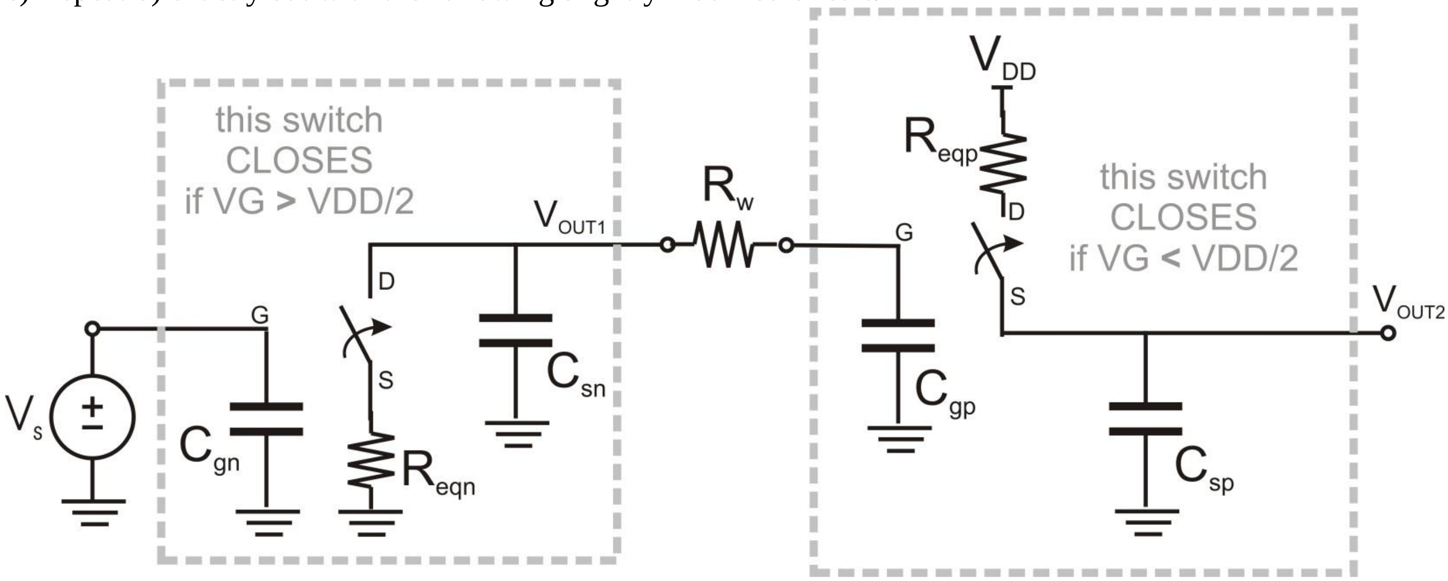
If:

- $Vs(t) = V_{DD}*u(t)$
- $V_{OUT1}(0) = V_{DD}$
- $V_{OUT2}(0) = 0$

Provide a **SYMBOLIC** expression for how long it takes for $V_{OUT2} > V_{DD}/2$. *(10 points)*

$t_{VOUT2}(s) =$

c) Repeat b) exactly but with the following slightly modified circuit.



If:

- $Vs(t) = V_{DD}*u(t)$
- $V_{OUT1}(0) = V_{DD}$
- $V_{OUT2}(0) = 0$

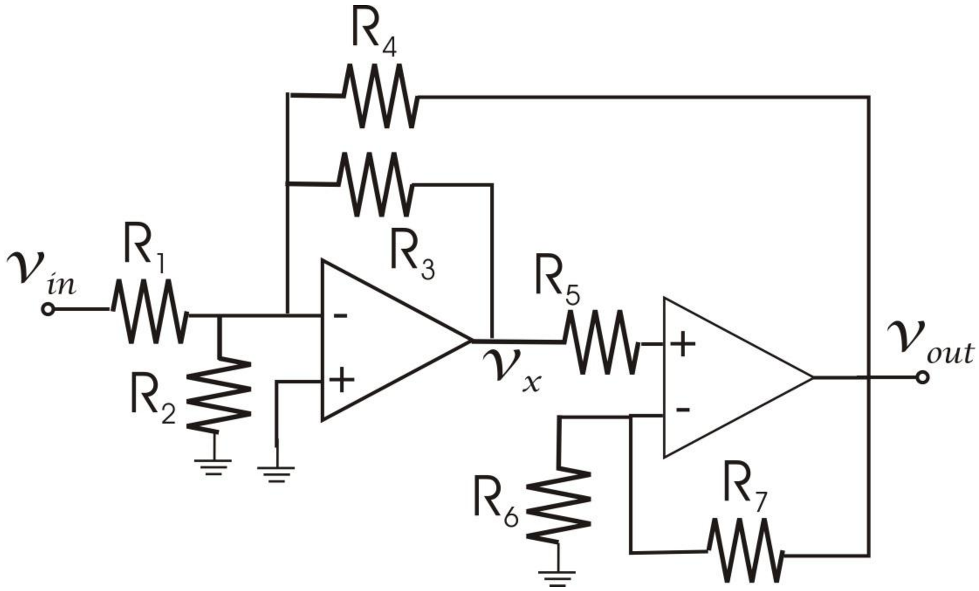
Provide a **<u>SYMBOLIC</u>** expression for how long it takes for $V_{OUT2} > V_{DD}/2$. *(10 points)*

t_{VOUT2}(s) =

"I don't see much sense in that," said Rabbit.
"No," said Pooh humbly, "there isn't. But there was going to be when I began it.
It's just that something happened to it along the way."
-Winnie the Pooh

Problem 3 *DC Op Amps (20 points)*

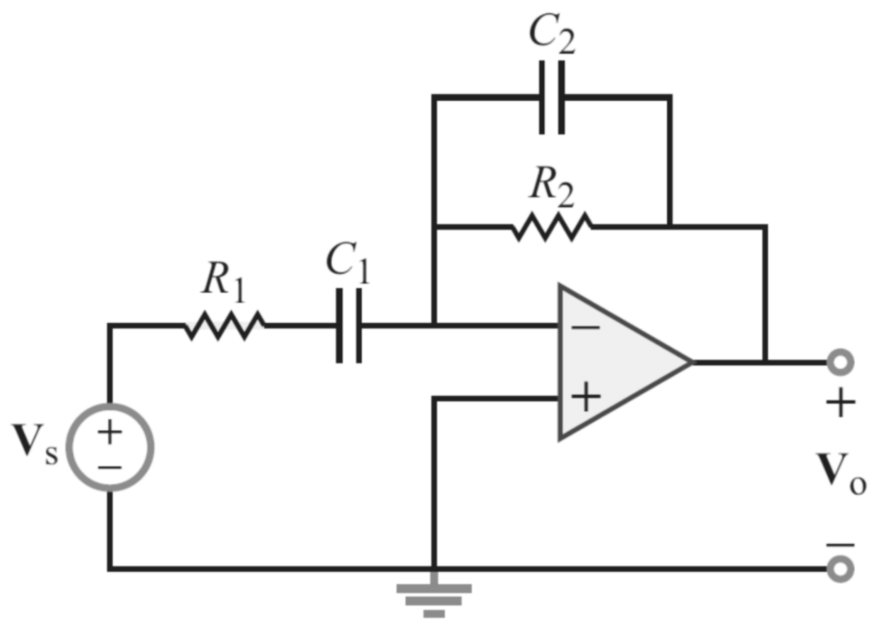
Consider the circuit below.



a) Provide a SYMBOLIC expression for $\frac{v_x}{v_{in}}$ *(10 points)* *b) Provide a SYMBOLIC expression for* $\frac{v_{out}}{v_{in}}$ *(10 points)*

"Art is a lie that makes us realize truth."
-Pablo Picasso

Problem 4 *Transfer functions*
Consider the circuit below:



a) Provide a **SYMBOLIC EXPRESSION** for the transfer function $H(\omega) = V_0/V_S$ *(10 points)*

(So I thought of making the exam purely symbolic, but then the memegenerator post made me realize I couldn't do this… so here are some numbers) ☺

b) Assuming the following component variables, list the frequencies (in rad/s) of each **zero** in the transfer function. *(5 points)*

R1 = 1 kΩ, R2 = 20 Ω, C1 = 5 µF, and C2 = 25 nF

Solution:

c) Assuming the following component variables, list the frequencies (in rad/s) of each **pole** in the transfer function. *(5 points)*

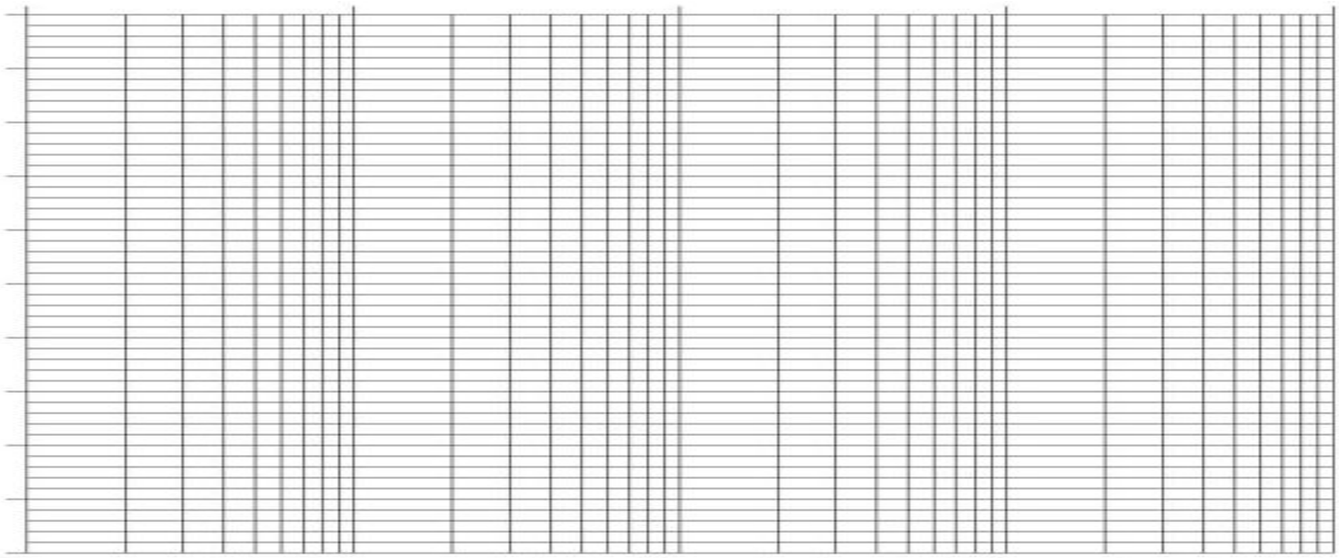
R1 = 1 kΩ, R2 = 20 Ω, C1 = 5 µF, and C2 = 25 nF

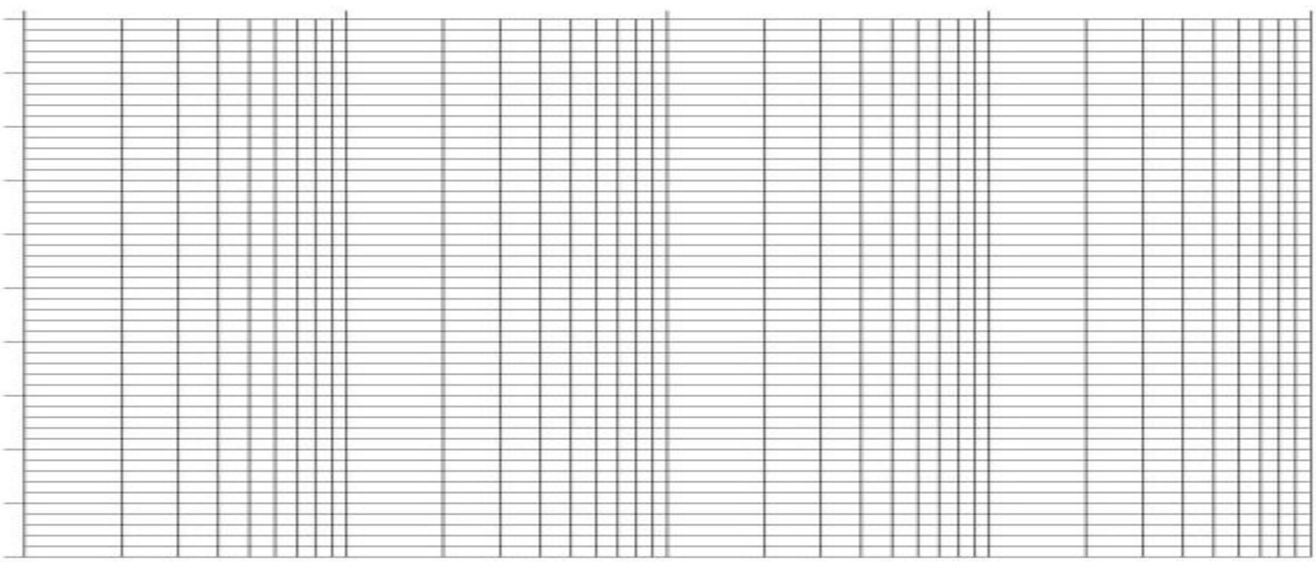
Solution:

d) Assuming the following component variables, draw the **magnitude** and **phase** Bode plots in the semilog paper below. *(10 points)*

R1 = 1 kΩ, R2 = 20 Ω, C1 = 5 μF, and C2 = 25 nF

DO NOT FORGET TO LABEL THE X AND Y AXES OR YOU WILL LOSE POINTS!





e) In **THREE WORDS OR LESS**, what does this circuit do? *(5 points)*

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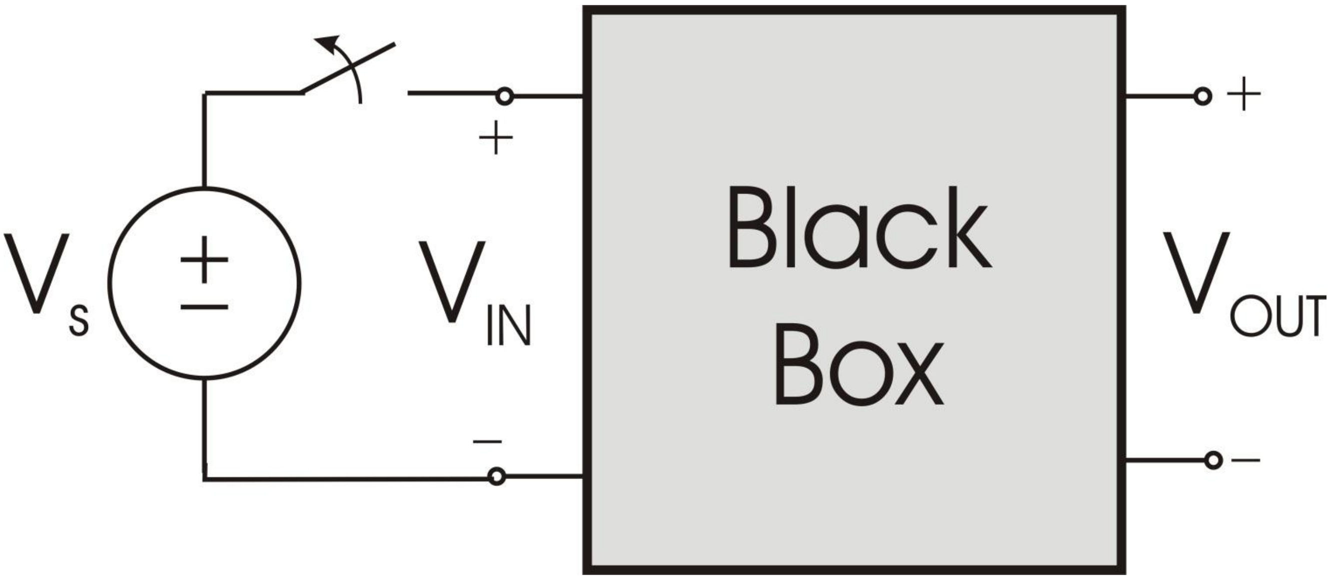
"So long, and thanks for all the fish
So sad that it should come to this
We tried to warn you all, but, oh, dear
You may not share out intellect
Which might explain your disrespect
For all the natural wonders that grow around you
So long, so long, and thanks for all the fish!"
—Douglas Adams, Hitchhiker's Guide to the Galaxy,

Problem 5 *Second order systems (25 points)*

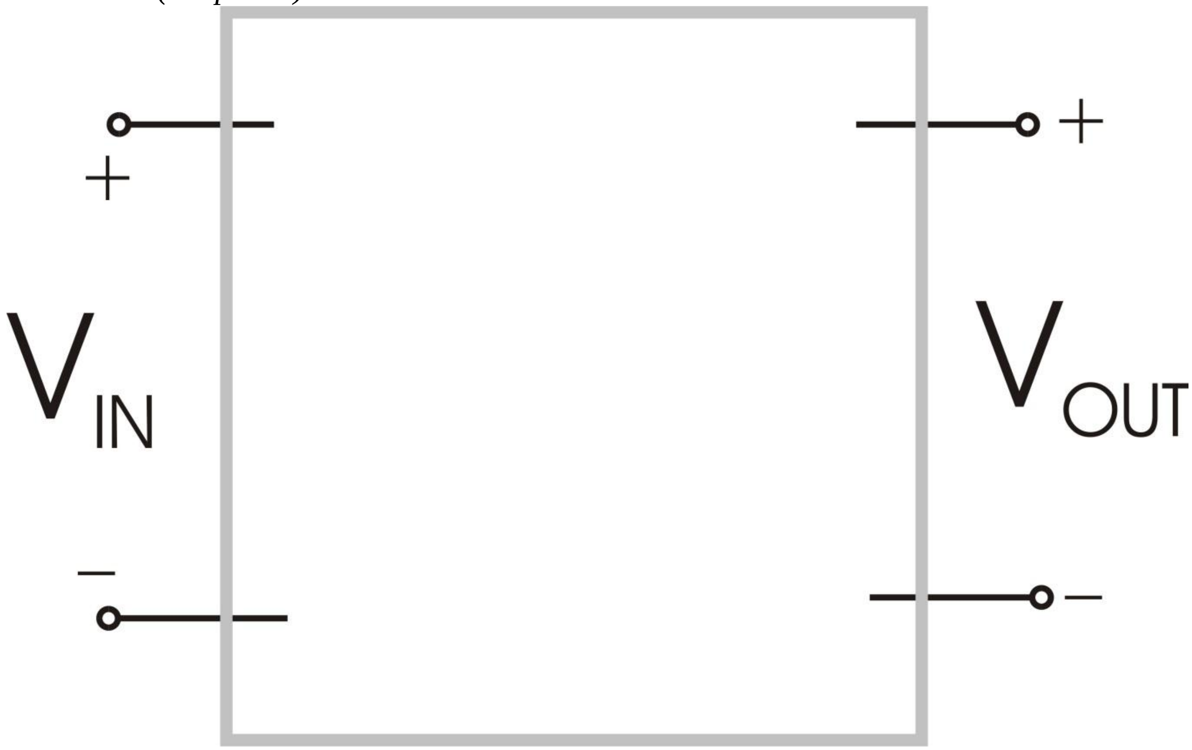
Consider the circuit below.



Design a passive circuit inside the black box which will produce an oscillating signal at 13.56 MHz once the switch is opened. The amplitude of the oscillation need not be constant but the frequency should not change with time.

- The available inductor ranges are 0.1 μH – 1 mH
- The available capacitor ranges are 10 pF - 10 μF
- The available resistor ranges are 100 Ω – 100 MΩ.
- There must be at least one resistor in the design.

a) Draw your circuit in the box below and label all components. Make sure to draw wired between all the input and output terminals. *(7.5 points)*



b) Given the component ranges, what is the highest Q achievable? *(7.5 points)*

c) What is the bandwidth for this Q? *(5.0 points)*

d) Change the value of one or more resistors in your design such that the circuit no longer oscillates. At what resistor value(s) is the boundary between oscillation and no oscillation? *(5 points)*