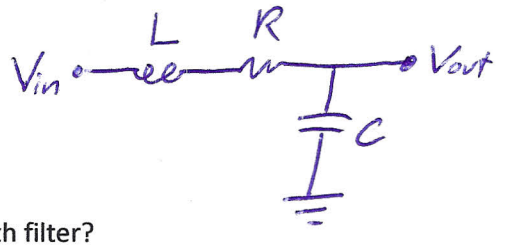
ECE100 Midterm Exam #1 Fall 2011

Don't forget:

- For all numerical answers, be sure to include units
- For plots, use a straight-line approximation. Label all relevant values for frequency, magnitude, phase, slope, intercept, etc.

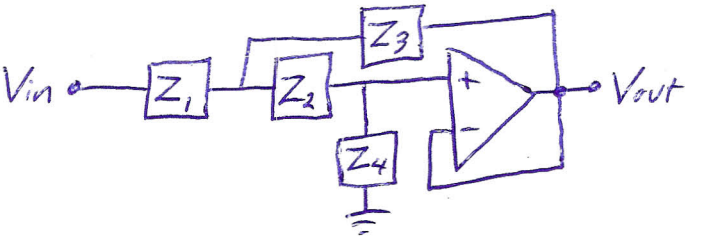
Question #1



For the circuit shown at the right:

a) Write the transfer function as a ratio of polynomials in s
b) For L=100nH and C=1nF, what is ω_0?
c) What value of R would make this a second order Butterworth filter?
d) Sketch a Bode plot of this transfer function for the component values given above.

Question #2

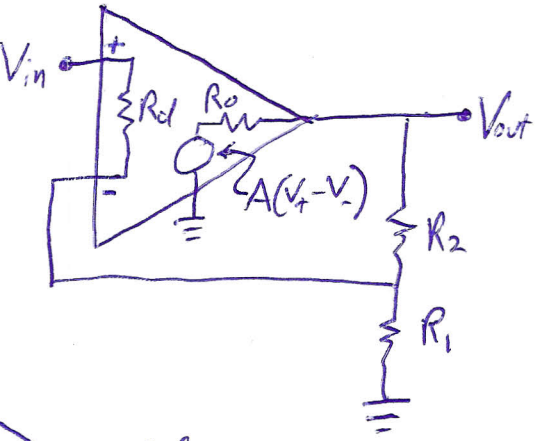


You have an op-amp, a box of 100pF capacitors, and a variety of resistors having any value you need. The Sallen-Key filter topology has the transfer function:

$$\frac{V_{out}}{V_{in}} = \frac{Z_3 Z_4}{Z_1 Z_2 + Z_3(Z_1 + Z_2) + Z_3 Z_4}$$

a) Using only the components above, draw a Sallen-Key circuit that has a high-pass filter response
b) Write the transfer function as a ratio of polynomials in s
c) Using only 100pF capacitors, what resistor values will give $\omega_0=10^5$ and $\zeta=0.5$?

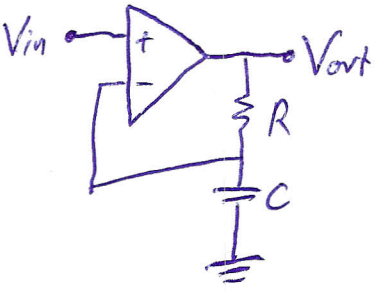
Question #3



For the voltage follower circuit, assuming the op-amp gain is A(s)=G/s

a) Derive the output impedance Z_{out} for $R_d = \infty$, and R_1 & R_2 >> R_o
b) Find the effective capacitance or inductance seen at the output for R_o=50Ω, G=10^6 rad/s, R_1=10kΩ, R_2=90kΩ

Question #4



For the circuit shown at right, the op-amp is characterized by $A(s) = \frac{A_0}{1+s\,\tau_A}$ where τ_A=1, and A_0=10^6. R=100kΩ and C=100pF.

a) Write an expression for the loop gain (AB)
b) Sketch a Bode plot of the loop gain.
c) Estimate the phase margin for this circuit.
d) Is it stable? Why or why not?