ECE100 Midterm Exam #1 Fall 2012

- 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.

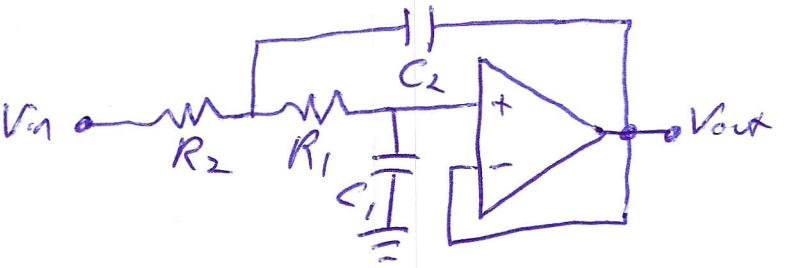
Question #1

For the circuit shown at right:

a) Write an expression for the transfer function in terms of R, L, and C, and identify the type of filter.

b) Assume the inductor has a value of 100 μH. Choose values of R and C that produce a 2nd order Butterworth filter with a cutoff frequency of $\omega_0=10^6$ rads/sec.

c) Sketch a Bode plot of this transfer function.



Question #2

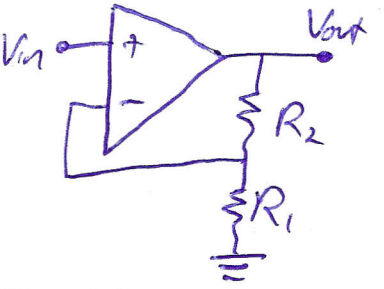
The Sallen-Key filter shown at right has a transfer function of

$$\frac{V_{out}}{V_{in}} = \frac{1}{1 + sC_1(R_1 + R_2) + s^2 R_1 R_2 C_1 C_2}$$

a) Assuming that $R_1=R_2$, and $C_1=C_2$, find the cut-off frequency and damping coefficient.

b) Now also assume that the op-amp has a finite output resistance R_o which is small compared to the other resistors. Derive an expression for the gain in the high-frequency limit.

c) If $R_o=100\Omega$, what resistor values ensure a high-frequency gain of less than -40dB?



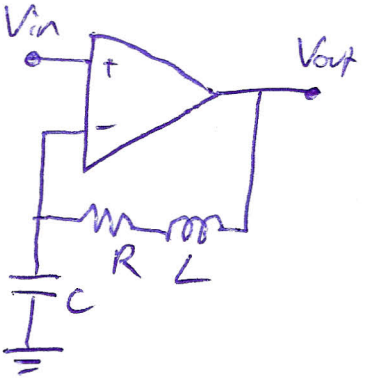
Question #3

For the voltage follower circuit,

a) Assuming the op-amp has finite gain, A, but is otherwise ideal, derive an expression for the transfer function of this circuit.

b) Next, assuming that the op-amp has frequency-dependent gain A(s)=G/s and finite differential input resistance R_d, derive an expression for the input impedance of the circuit.

c) Describe the input impedance in terms of an effective circuit, and find the value of any effective circuit parameters for $R_d=10k\Omega$, $G=10^6$ rad/sec, $R_1=10k\Omega$, $R_2=90k\Omega$



Question #4

For the circuit shown at right, assume the op-amp gain is A(s)=G/s

a) Write an expression for the loop gain, AB.

b) Sketch a Bode plot of the loop gain for R=20Ω, L=100μH, C=1μF, and $G=10^6$ rad/sec.

c) Sketch a Nyquist plot of the loop gain, and explain why it is stable or unstable.