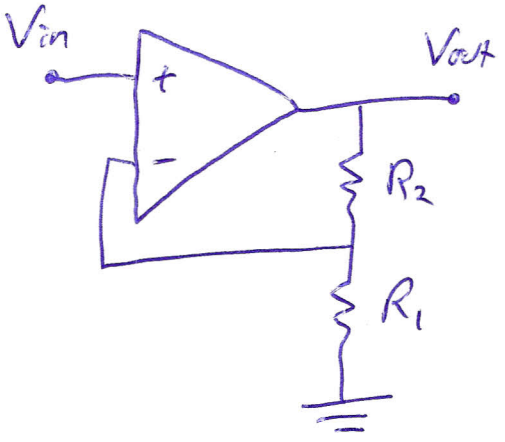
ECE100 Final Exam Fall 2012

Question #1

a) Sketch two non-trivially distinct ways to make a band-pass filter using a capacitor, an inductor and a resistor.
b) Calculate its transfer function for both circuits. Identify ω_0 and ζ.
c) Draw a Bode plot of the transfer function using a straight-line approximation Identify all relevant features - slopes, phases, peak locations and values.

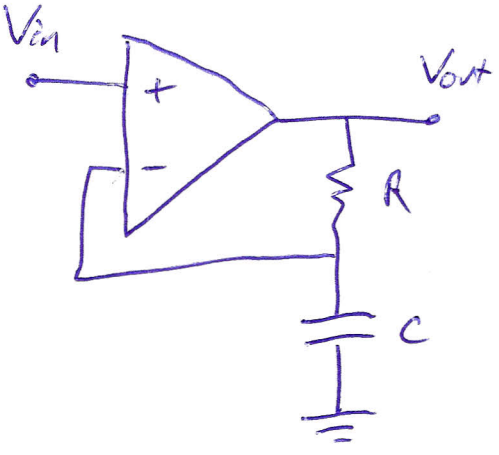
Question #2

a) For the circuit shown at right, derive the transfer function for an op-amp with gain A.
b) Now assuming A=G/s, and a differential input resistance of R_d, derive the capacitance seen at the input.
c) Next, assuming A=G/s, and an output resistance of R_o, derive the inductance seen at the output.



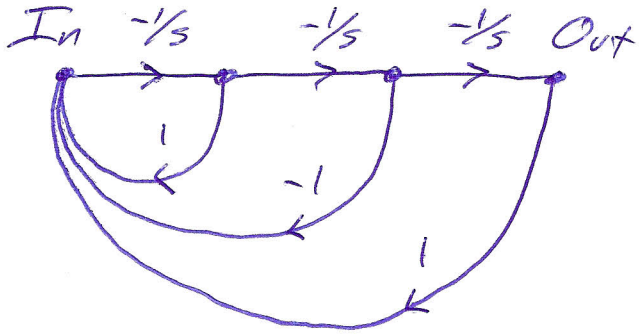
Question #3

a) For the circuit shown at right, assuming $A = \frac{G}{s} \times \frac{1}{1+s\tau}$ find the loop gain.
b) If G=10^8 rad/sec, τ=10^{-8} sec, R=1kΩ, C=100 pF, draw a Bode plot of the loop gain using a straight line approximation, and estimate the phase margin.
c) Where would you add a resistor to improve the phase margin, and why? What value of resistance would you choose?



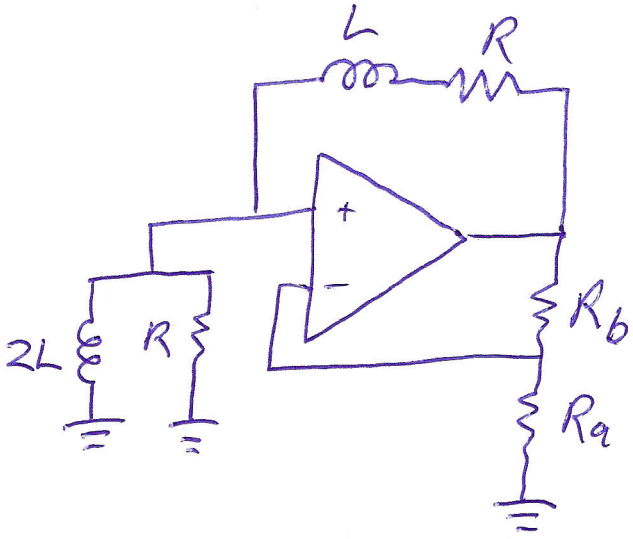
Question #4

a) Use Mason's gain formula to calculate the transfer function of the signal flow diagram shown at right.
b) Draw an alternative signal flow diagram that implements the identical transfer function.
c) Draw a circuit that implements the signal flow diagram at right using op-amp integrators and summing circuits.



Question #5

a) Calculate the loop gain for the circuit shown at right for the non-inverting input to the op-amp.
b) Find the condition for this circuit to work as an oscillator.
c) For this condition, sketch a Nyquist plot of the loop gain.



Question #6

a) For the circuit shown at right, assume that the op-amp outputs saturate at 10 volts. Find the relationship among the circuit components that will cause the output at node A to have an amplitude of 5 volts.
b) Find the relationship among the circuit components that will cause this circuit to oscillate at a frequency of 1 MHz.
c) For the conditions above, sketch the voltage at nodes A and B in the time domain.