ELEN 458/622 (ESS) **Due: November 3, 2009**

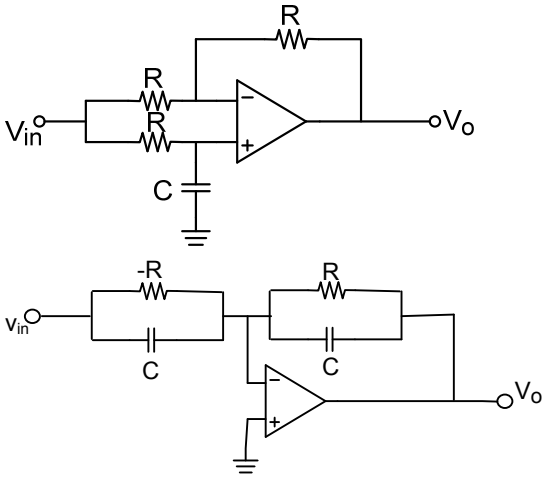
Homework Assignment # 4

Problem 1. Design a second-order active RC bandpass filter for $\omega_o = 2\pi$ x2x 10^6 r/s and Q = 12. You can pick the filter topology but you also **need to determine and justify the minimum value of the GBs of each Op Amp. Show your simulations using a suitable Op Amp macromodel. Show how degradation on Q occurs for different values smaller than optimal GB.** Discuss your Biquad topology selection. Find a commercial Op Amp capable of meeting the GB specification, provide details. Provide your results in a Table form

Problem 2. Same as problem 1 but using Gm-C filter implementation. The Gm macromodel should include gmo, excess phase and output resistance. Justify your results and discuss problems that need to be tackled to optimally design.

Problem 3. Design an oscillator based on results from problem 1, discuss your selection of the limiter such as a Schmit Trigger. Describe in detail your design equations and procedure. Plot the phase portraits, and frequency of oscillation when the suitable resistor are varied. Provide the frequency spectrum and the corresponding THD.

Prob 4. (just for 622) A First-Order All-Pass Filter can be implemented in different ways for Active-RC implementations.* Here two possible single ended versions are illustrated.



* L. Acosta, J. Ramirez-Angulo, A.J. Lopez-Martin and R. G. Carvajal, "Low-Voltage First-Order Fully Differential CMOS All-Pass Filter with Programmable Pole-Zero", *IEE Electronics Letters*, Vol. 45, No. 8, 9th April 2009.

Propose a fully-balanced fully symmetric version using two single-ended amplifiers. Simulate your version for

$$H(s) - \frac{1 - s/\omega_o}{1 + s/\omega_o}$$

$$\text{For } \omega_o = 2\pi \times 100\,\text{krad/sec}$$

Try also to propose a fully differential version.

.Reading Assignment:

Sections 4.4,4.5.1, 16.3.2 from textbook, " *Design of Analog Filters*" by R. Schaumann and M.E. Van Valkenburg, Oxford University Press 2001.