UNIVERSITY OF CALIFORNIA
College of Engineering
Department of Electrical Engineering
and Computer Sciences

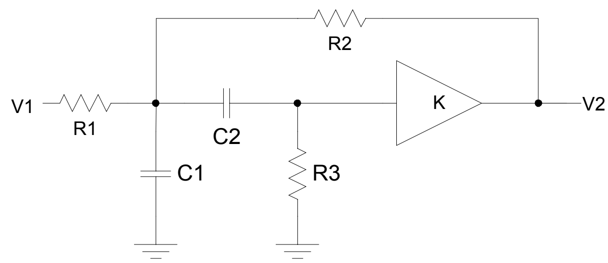
Homework 1 **EECS 247**

B.E. Boser **Due Thursday, September 11, 2003** **Fall 2003**
B. Murmann

1. Give the complete references to three publications of analog-digital interface circuits. E.g. A. J. Baker, "An adaptive cable equalizer for serial digital video rates up to 400Mb/s," *ISSCC Dig. Tech. Papers*, 1996, pp. 174-5.
   For at least one of the three publications list
   a) The purpose and applications of the circuit,
   b) Function and specifications of key building blocks,
   c) Questions you have about the circuit. For each question, indicate where you would expect to find the answer (course number, book, deriving it yourself, etc).
   Keep your answer to two pages.
   Possible sources: ISSCC digests, Journal of Solid-State Circuits (both in the Engineering Library). California digital library at http://www.cdlib.org (search the INSPEC database of the Melvyl catalog).

2. Design a 2^{nd} order (i.e. single biquad) bandpass filter with 1MHz center frequency and 200kHz 3dB-bandwidth.
   a) Calculate ω_P and Q_P.
   b) Plot a 3D perspective view of the magnitude and phase response of the filter.
   c) Implement the filter with a 2^{nd} order Sallen-Key section (see next page). Calculate all element values and the amplifier gain K. For simplicity (not the lowest sensitivity design!) make all capacitors 1pF and choose all resistors equal size. Calculate also the resulting filter gain G.
   d) Verify the transfer function with SPICE for nominal values and with a 5% variation of K. By how much are ω_P and Q_P changing?
   e) Calculate the sensitivity $S_K^{Q_P}$ and compare the analytical and simulation results.
   f) Return to nominal component values but add a 5% shunt capacitor to ground to both terminals of C_1 and C_2. By how much are ω_P and Q_P changing?

Second-order Sallen-Key bandpass section:



Design equations:

Transfer function

$$H_{BP}(s) = \frac{G\dfrac{\omega_o}{Q}s}{s^2 + \dfrac{\omega_o}{Q}s + \omega_o^2}$$

Center frequency

$$\omega_o = \sqrt{\frac{R_1 + R_2}{R_1 R_2 R_3 C_1 C_2}}$$

Quality factor

$$Q = \frac{\omega_o}{\dfrac{1}{R_1 C_1} + \dfrac{1}{R_3 C_2} + \dfrac{1}{R_3 C_1} + \dfrac{1-K}{R_2 C_1}}$$

Gain

$$G = \frac{\dfrac{K}{R_1 C_1}}{\dfrac{1}{R_1 C_1} + \dfrac{1}{R_3 C_2} + \dfrac{1}{R_3 C_1} + \dfrac{1-K}{R_2 C_1}}$$