ELEN 458 (ESS) **Due: November 15, 1999**
Fall '99

Homework Assignment #5

Prob. 1 Leapfrog Filter. Based on a third-order passive RLC Butterworth LP filter with a nominal cut-off frequency of 945 Hz.

(a) Obtain corresponding RLC prototype
(b) Write the state-variable equations describing the RLC
(c) Implement the active version using a block diagram approach and an active-RC or an OTA-C implementation.

Prob. 2 SC Biquad Design based on the several biquads shown in power point notes:

(a) Find the transfer function for Circuit 1 from notes (hint: use the corresponding block diagram and Mason's Rule).
(b) Assuming that the design equations are (where K is in v/v):

$$|K| = \frac{\alpha_5}{1+\alpha_8} \qquad (\omega_o T)^2 = \frac{\alpha_2\alpha_7}{1+\alpha 8} \qquad Q = \frac{\sqrt{\alpha_2\alpha_7(1+\alpha_8)}}{\alpha_8}$$

Design a circuit (capacitor values) with the following specifications:

f_c = 50Khz, f_o = 697 Hz, A_{vmax} = 1 v/v for all internal nodes at f_o, and Q = 25

(c) Simulate the filter using SWITCAP (or other SC simulator). Provide its frequency plot; magnitude and delay.
(d) Repeat (a) – (c) for Circuit 2. The design equations are (where K is in dB):

$$\frac{C_2}{C_{F1}} = \frac{C_3}{C_{F2}} \cong 2\pi f_o T \qquad \frac{C_2 C_4}{C_{F1}C_{F2}} = \frac{2\pi f_o T}{Q} \qquad \frac{C_1 C_2}{C_{F1}C_{F2}} = |K|$$

(e) Compare the total capacitance area of both circuits. Propose a modified structure of Circuit 2 that reduces the capacitance area (hint: use a "Qiunting Integrator" and a Offset and Gain Compensated Integrator).

EXTRA CREDIT: (A must for Graduate Students)

Repeat 2(b) for f_c = 6KHz, compare total capacitance area for all the cases. Discuss performance differences of the different designs and their strengths and weaknesses