E4215: Analog Filter Synthesis and Design: HW6

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due on 4 Mar. 2003

In addition to the problems here, problem #5 from HW5 is also due on 4 Mar. 2003

1. (1+3+3 pts.)Repeat the design in problem #5 of HW5 using opamps and *feedforward* technique. Use 10 pF capacitors.

   (a) Design the Butterworth lowpass filter.

   (b) Obtain the lowpass notch transfer function at the output V_1[1].

   (c) Obtain the lowpass notch transfer function at the output V_2.

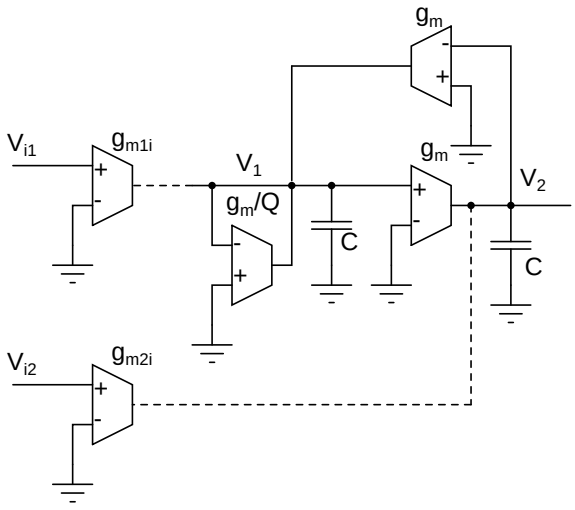

Figure 1:

2. (2 pts.) In Fig. 1, Determine the transfer functions from V_{i1} and V_{i2} to voltages V_1 and V_2.

[1]output of OPA1; in the handout "Transfer functions realizable in a biquad".

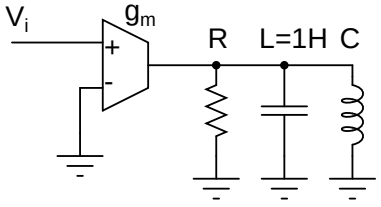

Figure 2:

3. (1+2+2+2+1+3 pts.) (a) Design a 1 H inductor using transconductors and a 100 pF capacitor.

   (b) Derive the (passive) equivalent circuit of the previously designed inductor if the capacitor had a 1 MΩ resistor across it.

   (c) Design an RLC bandpass filter with $\omega_p = 100$ krad/s and $Q = 10$ using a 1 H inductor. The gain at the resonant frequency should be 10. Use the topology in Fig. 2.

   (d) Replace the inductor with the equivalent circuit obtained in (b) and re-evaluate the transfer function $V_o(s)/V_i(s)$ What, if any, is the deviation from the intended design in (c).

   (e) How would you change the design to restore the Q to 10? You *cannot* remove the 1 MΩ resistor which is across the capacitor.

   (f) Simulate (i) the circuit in Fig. 2, (ii) the circuit with the inductor replaced by the active inductor[2], and (iii) the repaired circuit from (e).

[2]use the circuit with transconductors and capacitors, not the equivalent obtained in (b); Include the 1 MΩ resistor across the

Submit the magnitude and the phase responses;
overlay the responses of the three circuits.

100 pF capacitor.