SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Summer 2007
ENSC 320: ELECTRIC CIRCUITS II

LABORATORY: DESIGN and IMPLEMENT an ACTIVE FILTER

Objectives
Telephone speech signals have bandwidth of 300 - 3,400 Hz. Design a low pass filter to suppress interference by attenuating interference signals by at least 30 dB starting at 11 kHz. The telephone signal should not be attenuated more than 0.5 dB.

Design

- Examine Butterworth and Chebyshev filter realizations that meet the specifications.
- Plot frequency responses using MATLAB.
- Select the most appropriate filter type, order, and filter parameters.
- Design the filter using Sallen-Key stages with an overall gain in the range 2 to 3.
- Simulate your design using PSPICE.
- Build the filter circuit, test it, and compare its performance to the specifications and to PSPICE predictions.

Background and Preparation

- Read *Hints for Effective Op Amp Circuit Design* from the *Supplementary Notes and Demos section* of the ENSC 320 Spring 2005 web site. It covers practical issues in making your circuits work.
- View the animations of how R and C component tolerances affect the frequency responses of 5th order filters, also on the *Supplementary Notes and Demos* section of the ENSC 320 Spring 2005 web site.
- Read *Lab 1, section Useful Resources* of the ENSC 320 Spring 2006 web site.

Parts
Register your lab team with the TA. Collect a kit with various components from Marius Haiducu. The kit contains:

- quad op amp: TL074CP
- various resistors (kΩ range)
- capacitors in the nF range:
  - 22 nF caps, quantity 4
  - 10 nF caps, quantity 4
  - 3.3 nF caps, quantity 4
  - 1 nF caps, quantity 4
- power supply isolation capacitors (0.1 μF, quantity 4).

Test Measurements

- Input a sinusoidal wave of 2 V peak-to-peak and plot the frequency response (magnitude and phase Bode plots) for the range from 10 Hz to 1 MHz.
- Compare your results with PSPICE simulations.

Design Notes

- Choose resistors so that the overall gain is not so high that the voltages exceed the power rails.
- Use capacitors above 100 pF, preferably in the nF range.
- Use clean voltage supplies (i.e., 0.1 μF capacitors at +Vcc and −Vcc, where Vcc = 12 V).

Optional

When you have your circuit working, try couple of optional steps (they will not affect your mark):

- Filter speech and noise. There are some black (beige, actually) boxes available with amps, summers, a noise source, and tunable switched capacitor filters.
- Find a microphone, add some noise with bandwidth 20 kHz or so, and listen to the result with and without the filter you built.
- Redesign a second order stage with very small capacitors, such as 10 pF. You will probably find your circuit oscillating, instead of amplifying.

Lab Report

Include title page and a **maximum** of additional **10** pages. Describe your design and the performance of your implementation. Explain differences between your expectations and the actual filter performance.