

EE 508

Lab 4 Sensitivity Analysis of Filter Structures

Fall 2022

Due Tuesday October 18

Two second-order bandpass filters are shown below. Characteristics of the first filter were discussed in the lecture. There have been claims that the second has better performance. Assume both are designed with  $C_1=C_2=C$ .

Part 1 Obtain parametric expressions for the transfer functions of both filters including the effects of the operational amplifier time constant (i.e. assume Op Amp gain is  $A(s) = \frac{GB}{s} = \frac{1}{\tau s}$ )

Part 2 Obtain parametric expressions for  $\omega_0$  and  $Q$  for both filters if the op amps are ideal.

Part 3 Analytically obtain approximate expressions for  $\frac{\Delta Q}{Q}$  and  $\frac{\Delta f_0}{f_0}$  due to changes in  $R_1$  and due to changes in  $\tau=GB^{-1}$  for both circuits ( $\omega_0=2\pi f_0$ )

Part 4 Design both filters for a nominal  $Q=10$  and  $f_0=10\text{KHz}$  if the operational amplifiers are ideal. In the design of the second circuit, select a value of  $H$  that will make  $\frac{\Delta Q}{Q}$  due to changes in  $\tau$  small.

Part 5 If the  $GB$  or the Op Amp is  $1\text{MHz}$ , how do  $\frac{\Delta Q}{Q}$  and  $\frac{\Delta f_0}{f_0}$  obtained from the analytical expressions obtained in Part 2 compare to the actual  $\frac{\Delta Q}{Q}$  and  $\frac{\Delta f_0}{f_0}$ ?

Part 6 Comment on the relative performance of these two filter architectures.

