ECE 321: Handout #9

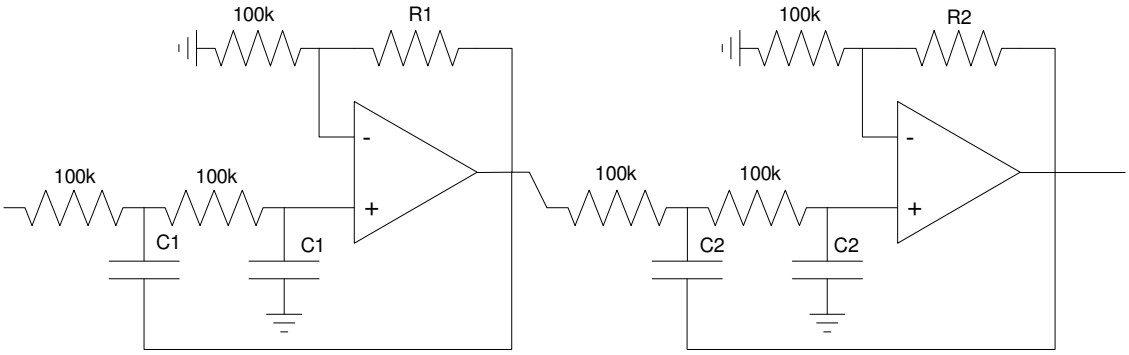
Butterworth and Chebychev Filters

1) The transfer function for a 4th-order Chebychev filter with a corner at 1 rad/sec is

$$G(s) = \left(\frac{0.639}{\left(s+0.72\angle\pm 38.5^0\right)\left(s+1.11\angle\pm 77.8^0\right)} \right)$$

a) Determine R and C for a 4th-order Chebychev filter with a corner at 1 rad/sec

b) Determine R and C for a 4th-order Chebychev filter with a corner at 250Hz



Solution

Treat this as two cascaded filters

$$G(s) = \left(\frac{0.72^2}{\left(s+0.72\angle\pm 38.5^0\right)}\right)\left(\frac{1.11^2}{\left(s+1.11\angle\pm 77.8^0\right)}\right)$$

Stage 1:

$$\frac{1}{RC} = 0.72$$

$$R = 100k \qquad C = 13.889\mu F$$

$$3-k = 2\cos(38.5^0)$$

$$k = 1.435 = 1+\frac{R_a}{R_b}$$

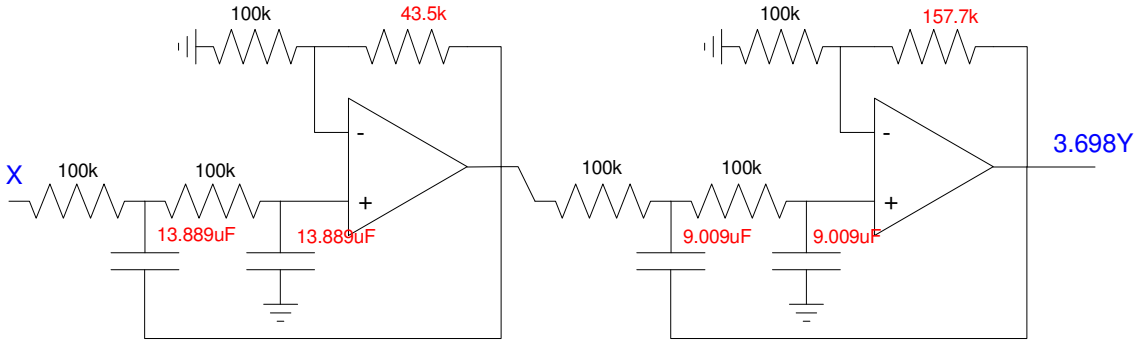
Stage 2:

$$\frac{1}{RC} = 1.11$$

$$R = 100k \qquad C = 9.009\mu F$$

$$3-k = 2\cos(77.8^0)$$

$$k = 2.577 = 1+\frac{R_a}{R_b}$$



The DC gain is

$$DC = (1.435)(2.577) = 3.698$$

2) Design a 4th-order Butterworth filter with a corner at 250Hz

Solution: It's the same circuit as before, just make the capacitors smaller

$$C(250Hz) \rightarrow \left(\frac{1 \text{ rad/sec}}{250Hz \cdot 2\pi}\right) C = \left(\frac{1}{1570.796}\right) C$$

$$13.889\mu F \rightarrow \left(\frac{13.889\mu F}{1570.796}\right) = 8.84nF$$

$$9.009\mu F \rightarrow \left(\frac{9.009\mu F}{1570.796}\right) = 5.73nF$$