ECE 321 - Quiz #3. Name

Filter Design. April 19, 2018

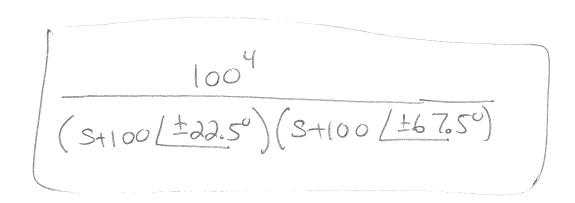
1) The transfer function for a 4th-order Butterworth filter with a corner at 1 rad/sec is

$$G(s) = \left(\frac{1}{\left(s+1\angle \pm 22.5^{0}\right)\left(s+1\angle \pm 67.5^{0}\right)}\right)$$

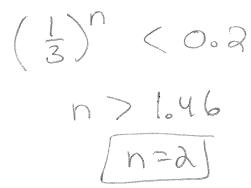
$$G(s) = \left(\frac{1}{\left(s^{2}+1.8478s+1\right)\left(s^{2}+0.7654s+1\right)}\right)$$

Give the transfer function for a 4th-order Butterworth filter with

- A corner at 100 rad/sec, and
- A DC gain of 1.000



- 2) Design a low-pass filter to meet the following requirements:
 - 0.9 < gain < 1.1 $\omega \le 10$ rad/sec
 - gain < 0.2 $\omega \ge 30$ rad/sec
- 2a) How many poles do you need for this filter?



2b) Suggest the transfer function for a filter which meets (or comes close to meeting) these requirements.

pick Butterworth

Corner=10

angle=180°/2=\$90°

10²

(S+10 L=45°)

- 3) Design a low-pass filter to meet the following requirements:
 - 0.9 < gain < 1.1 $\omega \le 10$ rad/sec
 - gain < 0.02 $\omega \ge 30$ rad/sec
- 2a) How many poles do you need for this filter?

$$(\frac{1}{3})^n < 0.02$$
 $n > 3.56$
 $(n = 4)$

2b) Suggest the transfer function for a filter which meets (or comes close to meeting) these requirements.

4) The frequency content of a 10 rad/sec (1.6Hz) square wave is

$$x(t) = 6\sin(10t) + 2\sin(30t) + \dots$$

To turn this into a sine wave, the following low-pass filter is proposed:

$$Y = \left(\frac{2000}{(s+8.5)(s+12.1 \angle 69.5^{\circ})(s+12.1 \angle -69.5^{\circ})}\right)X = \left(\frac{2000}{(s+8.5)(s^{2}+8.475s+146.41)}\right)X$$

Find y(t)

$$S=310$$

$$()_{j0} = 1.577[-110^{\circ}] ()_{330} = .0806[124^{\circ}]$$

$$y=(1.577[-110^{\circ}](0-j6)) | y=(.0806[124^{\circ}](0-j2))$$

$$y=9.46[159^{\circ}] | y=.161[34^{\circ}]$$

y(t)= 9.46 cus (10t +1590) + 0.161 cos (30t +340)

mosts a pure sine reace

5) The frequency content of a 10 rad/sec (1.6Hz) square wave is

$$x(t) = 6\sin(10t) + 2\sin(30t) + \dots$$

To turn this into a sine wave, the following band-pass filter is proposed:

$$Y = \left(\frac{2s}{s^2 + 2s + 100}\right) X = \left(\frac{2s}{(s+1+j9.95)(s+1-j9.95)}\right) X$$

Find y(t)

$$S = \frac{1}{3}10$$

() $\frac{1}{3}10 = \frac{1}{3}$
 $y = (1)(0-\frac{1}{3}6)$
 $y = -\frac{1}{3}6 = 6[-90^{\circ}]$
 $y = 6 \cdot \cos(106 - 90^{\circ})$

S=30 () = .0748L-850 y= (.0748/-85°) (0-j2) 4= 0.149 cos (30+ -175°)

4= 6 sin(10t) + 6.149 cos(306-1750) mostly 1st harmonic

Bernie Sanders vs. Godzilla Bonus!!! Which is more (i.e. who's more popular)?

The number of people who voted for Bernie Sanders in 2016, or — 1.6 million

The number of people who saw Godzilla 2014 in the theater?

30 million \$300 million in ticket soles