

# ECE 321 - Quiz #4 - Name \_\_\_\_\_

Filters, Filter Design, Analog Computers. Due midnight, March 29th

1) X and Y are related by

$$Y = \left( \frac{20s+30}{(s+M)(s+D)} \right) X$$

where

- M is your birth month (1..12), and
- D is your birth date (1..31)

Determine  $y(t)$  assuming

$$x(t) = 3 + 4 \sin(5t)$$

2) Design an op-amp circuit (a.k.a. an analog computer) to implement

$$Y = \left( \frac{20s+30}{(s+M)(s+D)} \right) X$$

where

- M is your birth month (1..12), and
- D is your birth date (1..31)

3) The transfer function for a 6th-order Chebychev filter with a corner at 1 rad/sec is

$$G(s) = \left( \frac{0.1593}{(s+0.4722\angle\pm 36.10^\circ)(s+0.8100\angle\pm 69.83^\circ)(s+1.0436\angle\pm 84.38^\circ)} \right)$$

Give the transfer function for a 6th-order Chebychev filter with

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

where

- $X = 1000 + 100 * (\text{your birth month}) + (\text{your birth date})$

4) Give the transfer function for a 7th-order Butterworth filter with

- A DC gain of 1.000 and
- A corner at  $X$  rad/sec

where

- $X = 1000 + 100 * (\text{your birth month}) + (\text{your birth date})$

5) Specify a filter to meet the following requirements:

- $0.9 < \text{gain} < 1.1$        $0 < \omega < 300 \text{ rad/sec}$
- $\text{gain} < 0.1$                $\omega > 450 \text{ rad/sec}$

5a) How many poles does the filter need?

5b) Give the transfer function of a filter,  $G(s)$ , which meets these requirements

5c) What is the gain of your filter at 300 and 450 rad/sec?

# poles needed	$G(s)$	Gain at 300 rad/sec	Gain at 450 rad/sec

6) The difference between a square wave and a sine wave is a square wave has a 3rd harmonic. Design a filter to remove the 3rd harmonic (make it 30x smaller in amplitude than the 1st harmonic)

- $0.9 < \text{gain} < 1.1$        $0 < \omega < 200 \text{ rad/sec}$
- $\text{gain} < 0.1$                $\omega > 300 \text{ rad/sec}$

6a) How many poles does the filter need?

6b) Give the transfer function of a filter,  $G(s)$ , which meets these requirements

6c) What is the gain of your filter at 200 and 300 rad/sec?

# poles needed	$G(s)$	Gain at 200 rad/sec	Gain at 300 rad/sec