CE 321 - Quiz #2. Name _____

Active Filters. April 12, 2018

1) X and Y are related by the following transfer function

$$Y = \left(\frac{150}{(s+2)(s+4)(s+10)}\right)X = \left(\frac{150}{s^3+16s^2+68s+80}\right)X$$

1a) What is the differential equation relating X and Y?

$$y''' + 16y'' + 68y' + 80y = 150x$$

1b) Find y(t) assuming

$$x(t) = 5 + 6\cos(7t)$$

$x(t) = 5$

$s = 0$

$( )_{s=0} = 1.875$

$y = 1.875 \cdot 5$

$y = 9.375$

$x(t) = 6 \cdot \cos(7t)$

$s = j7$

$( )_{s=j7} = .209 \angle -169°$

$y = 1.25 \angle -169° = (.209 \angle -169°)(6)$

$y = 1.25\cos(7t - 169°)$

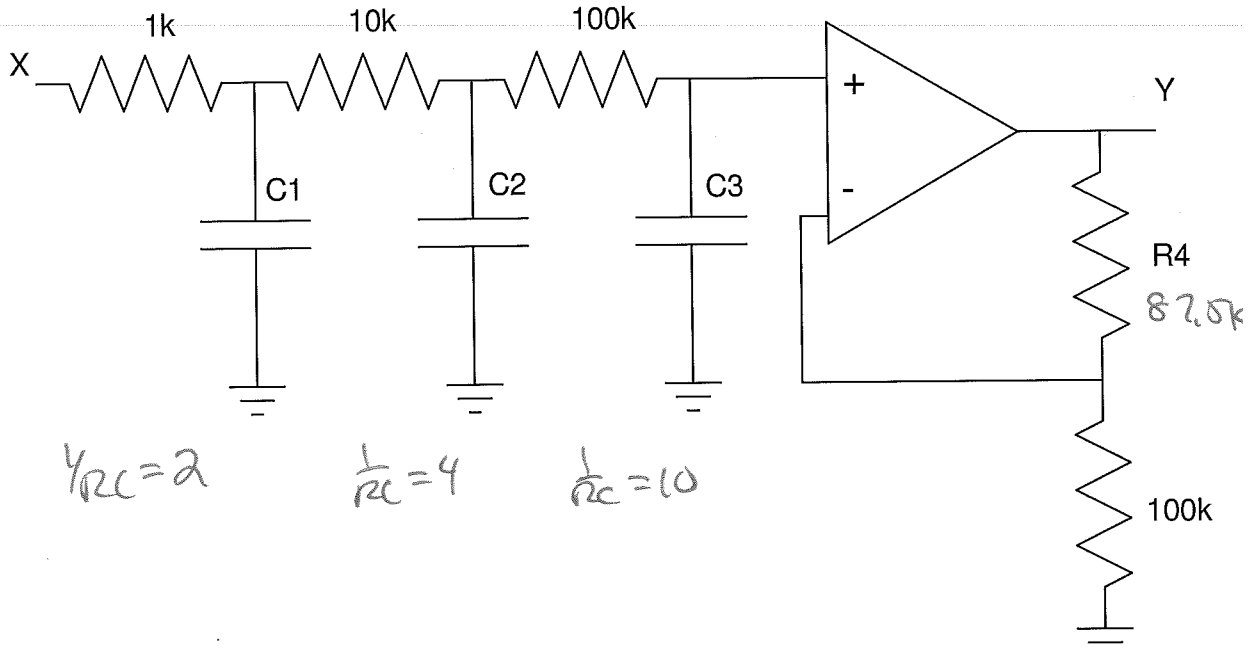
$$y = 9.375 + 1.25\cos(7t - 169°)$$

2) X and Y are related by the following transfer function:

$$Y = \left(\frac{150}{(s+2)(s+4)(s+10)}\right)X = \left(\frac{150}{s^3+16s^2+68s+80}\right)X$$

Specify R and C values so that the following circuit implements this transfer function

C1	C2	C3	R4
500μF	125μF	1μF	87.5k



$\frac{1}{RC}=2$ $\frac{1}{RC}=4$ $\frac{1}{RC}=10$

DC gain = 1.875

3) X and Y are related by the following transfer function:

$$Y = \left(\frac{2000}{(s+8.5)\left(s+12.1\angle 69.5^0\right)\left(s+12.1\angle -69.5^0\right)} \right) X$$

Find y(t) assuming

$$x(t) = 5 + 6\cos(7t)$$

$x(t) = 5$

$s = 0$

~~$y = (1.607)(5)$~~

$(\quad)_{s=0} = 1.607$

$y = 1.607 \cdot 5$

$y = 8.035$

$x(t) = 6\cos(7t)$

$s = j7$

$(\quad)_{s=j7} = 1.59\angle -71^\circ$

$y = (1.59\angle -71^\circ) \cdot 6$

$y = 9.55\angle -71^\circ$

$y(t) = 9.55\cos(7t - 71^\circ)$

$$y = 8.035 + 9.55\cos(7t - 71^\circ)$$

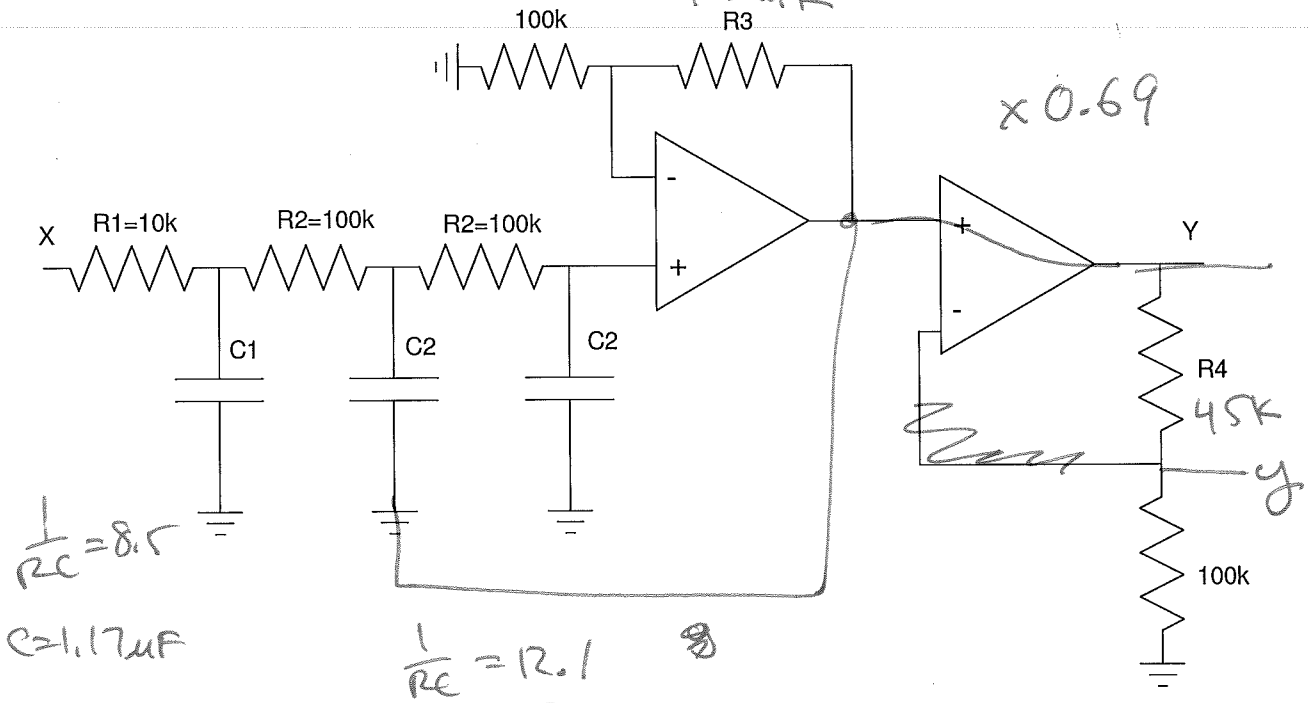
4) X and Y are related by the following transfer funciton:

$$Y=\left(\frac{2000}{(s+8.5)\left(s+12.1\angle 69.5^0\right)\left(s+12.1\angle -69.5^0\right)}\right)X$$

DC gain = 1.607

Specify R and C's so that the following filter implements this transfer function

C1	C2	R3	R4
1.17μF	.826μF	119.9k	gain = 0.69



$\left(\frac{\frac{1}{R_1 C_1}}{s+\frac{1}{R_1 C_1}}\right)$ $\left(\frac{k\left(\frac{1}{R_2 C_2}\right)^2}{s^2+\left(\frac{3-k}{R_2 C_2}\right)s+\left(\frac{1}{R_2 C_2}\right)^2}\right)$ $\left(1+\frac{R_4}{100{,}000}\right)$

3.1k

6.9k

$$k=\left(1+\frac{R_3}{100{,}000}\right)$$

DC gain = 2.299

$(s^2 - k(\frac{1}{RC})s =$

$3-k = 2\cdot\cos\theta$

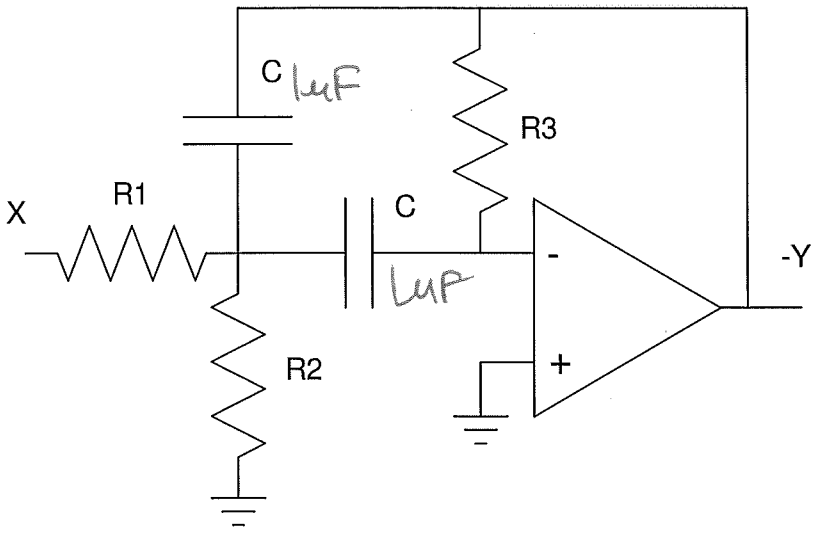
$k = 2.299$

5) X and Y are related by the following transfer funciton:

$$Y = \left(\frac{5s}{s^2+15s+200}\right)X = \left(\frac{-\left(\frac{1}{R_1C}\right)s}{s^2+\left(\frac{2}{R_3C}\right)s+\left(\frac{R_1+R_2}{R_1R_2R_3C^2}\right)}\right)X$$

Specify R and C's so that the following filter implements this transfer function

R1	R2	R3	C
20k	46.1k	133k	1uF



$\frac{1}{R_1C} = 5$ $\quad$ $\frac{2}{R_3C} = 15$

$R_1 = 20k$ $\quad$ $R_3 = 133k$

$\frac{R_1+R_2}{R_1R_2R_3C^2} = 200$

Bernie Sanders vs. Godzilla Bonus! Which is more:

- The number of times Bernie Sanders has run for public office, or
- The number of Godzilla movies made?

$\left(\frac{R_1+R_2}{R_1R_2}\right) = 266.10^{-6}$ $\quad$ $R_2 = 46.1k$

$\frac{R_1R_2}{R_1+R_2} = 37.5k$

$R_1 \| R_2 = 37.5k$