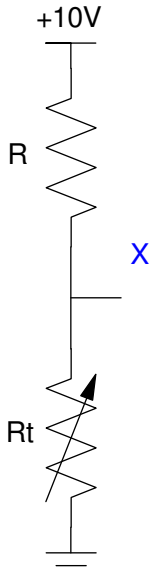
ECE 321 - Quiz #2 - Name _____

Tempeature Sensors & Active Flters

1) A thermistor has a temperature-resistance relationship where T is the temperature in degrees C.

$$R_t = 2000 \cdot \exp\left(\frac{3000}{T+273} - \frac{3000}{298}\right)\ \Omega$$



Assume

R = 800 + 100*(your birth month) + (your birth day)

If X = 4.00V, determine the resistance, R, and the temperature, T

R 800 + 100*mo + day	X volts	Rt Ohms	T degrees C
1314	***6.73V***	**2704.35**	**16.33C**

$$X = \left(\frac{R_t}{R_t+1314}\right)10V$$

$$R_t = \left(\frac{X}{10-X}\right) \cdot 1314\Omega = 2704.349\Omega$$

$$T = 16.329^0 C$$

2) A thermistor has a temperature-resistance relationship where T is the temperature in degrees C.

$$R_t = 2000 \cdot \exp\left(\frac{3000}{T+273} - \frac{3000}{298}\right)\ \Omega$$

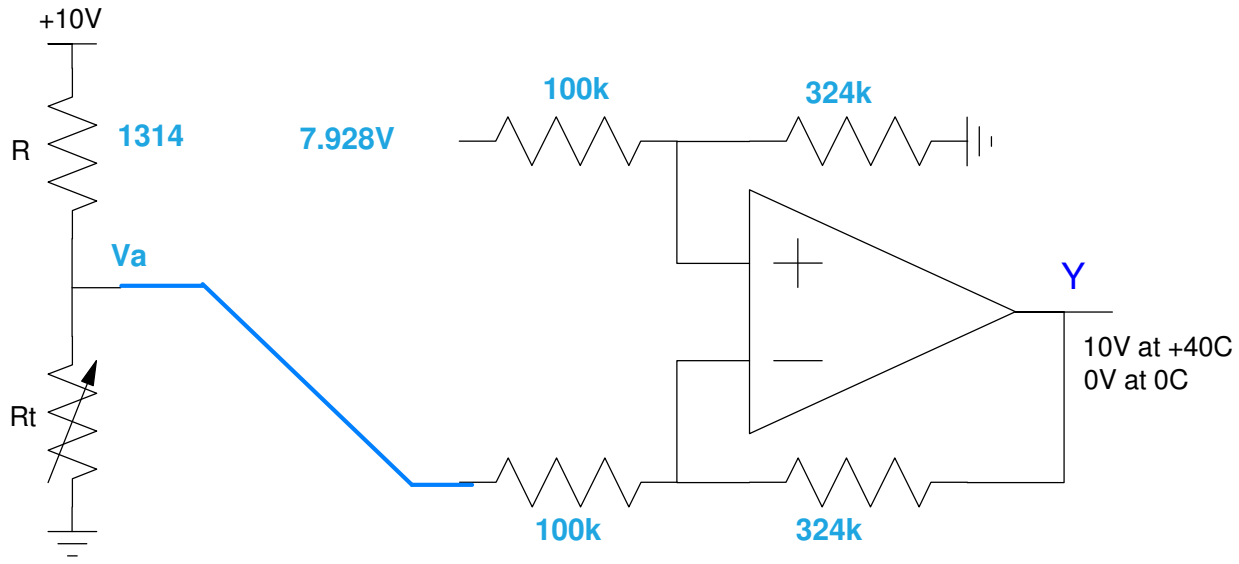
Design a circuit which outputs

- 0V at 0C and
- +10V at +40C

Assume

R = 800 + 100*(your birth month) + (your birth day)

note: A linearizing circuit isn't required.



At 0C: Y = 0V

R = 5028.11 Ohms

$$V_a = \left(\frac{R}{R+1314}\right)10V = 7.928V$$

At +40C, Y = 10V

R = 1234.539 Ohms

Va = 4.844V

As Va goes down, Y goes up. Connect to the plus input

When Va = 7.92V, Y = 0V. Make the offset 7.92V

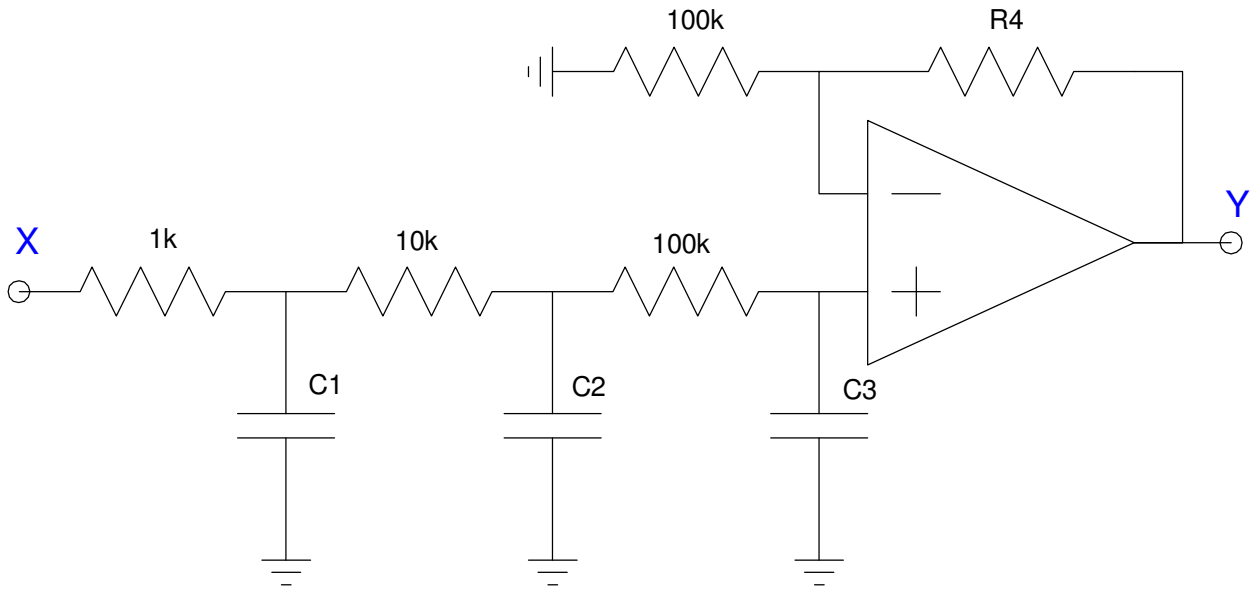
$$gain = \left(\frac{10V-0V}{7.928V-4.844V}\right) = 3.243$$

3) Find C1, C2, C3, and R4 so that this circuit implements

$$Y = \left(\frac{10000}{(s+3)(s+m)(s+d)} \right) X$$

where

- m is you birth month (1..12) and
- d is your birth date (1..31)



m month	d day	C1 uF	C2 uF	C3 uF	R4 Ohms
5	**14**	333.3uF	20.0uF	714nF	4.662M

DC gain is

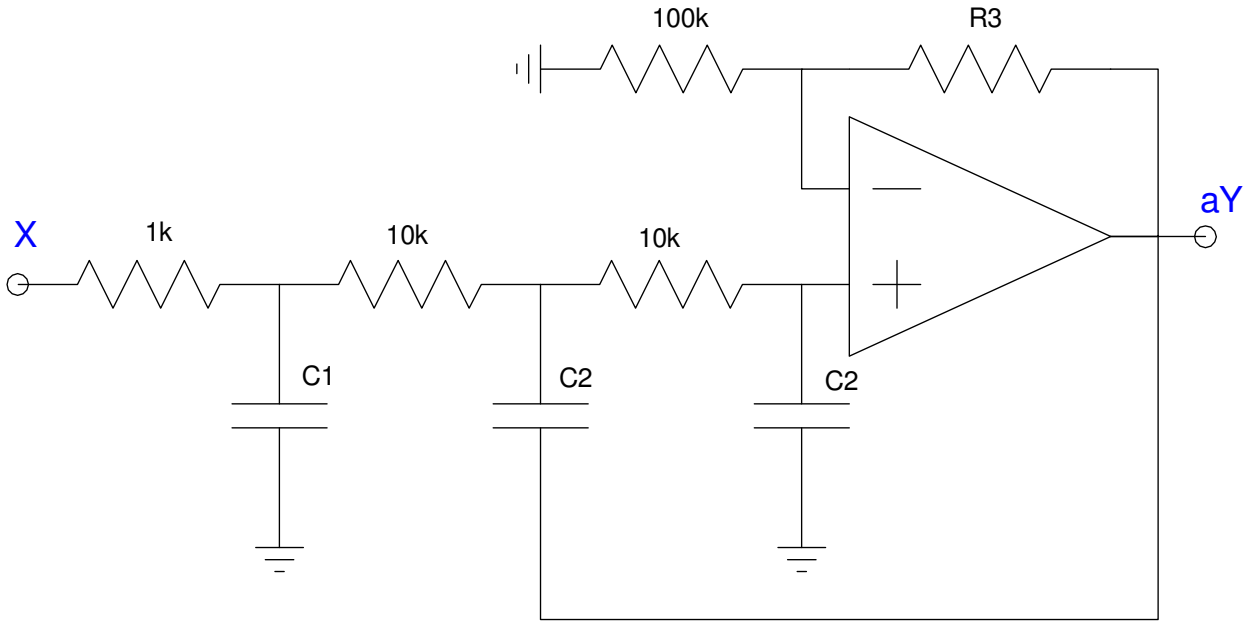
$$\left(\frac{10000}{(s+3)(s+5)(s+14)} \right)_{s=0} = 47.62$$

4) Find R's and C's so that the following circuit implements

$$Y = \left(\frac{10{,}000}{(s+3)(s+m+jd)(s+m-jd)} \right)$$

where

- m is your birth month (1..12), and
- d is your birth date (1..31)



m month	d day	C1 uF	C2 uF	R3 k Ohms	a output is a*Y
5	**14**	**333uF**	**6.72uF**	**132.7k**	**0.15**

The pole is

$$s = -5 + j14 = -14.87 \angle 70.35^0$$

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

$$k = 2.327$$

The DC gain should be

$$\left(\frac{10{,}000}{(s+3)(s+5+j14)(s+5-j14)} \right)_{s=0} = 15.08$$

so the output is scaled by

$$a = \frac{2.327}{15.08} = 0.154$$

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

$$Y = \left(\frac{10000}{(s+3)(s+m)(s+d)} \right) X$$

where

- m is your birth month (1..12), and
- d is your birth date (1..31)

Assume

$$x(t) = 5 + 6\cos(2t) + 7\sin(2t)$$

Determine y(t) (i.e. find a, b, and c)

$$y(t) = a + b\cos(2t) + c\sin(2t)$$

DC: x(t) = 5

$$Y = \left(\frac{10000}{(s+3)(s+5)(s+14)} \right)_{s=0} \cdot (5)$$

$$Y = 238.1$$

AC: x(t) = 6 cos(2t) + 7 sin(2t)

$$Y = \left(\frac{10000}{(s+3)(s+5)(s+14)} \right)_{s=j2} \cdot (6 - j7)$$

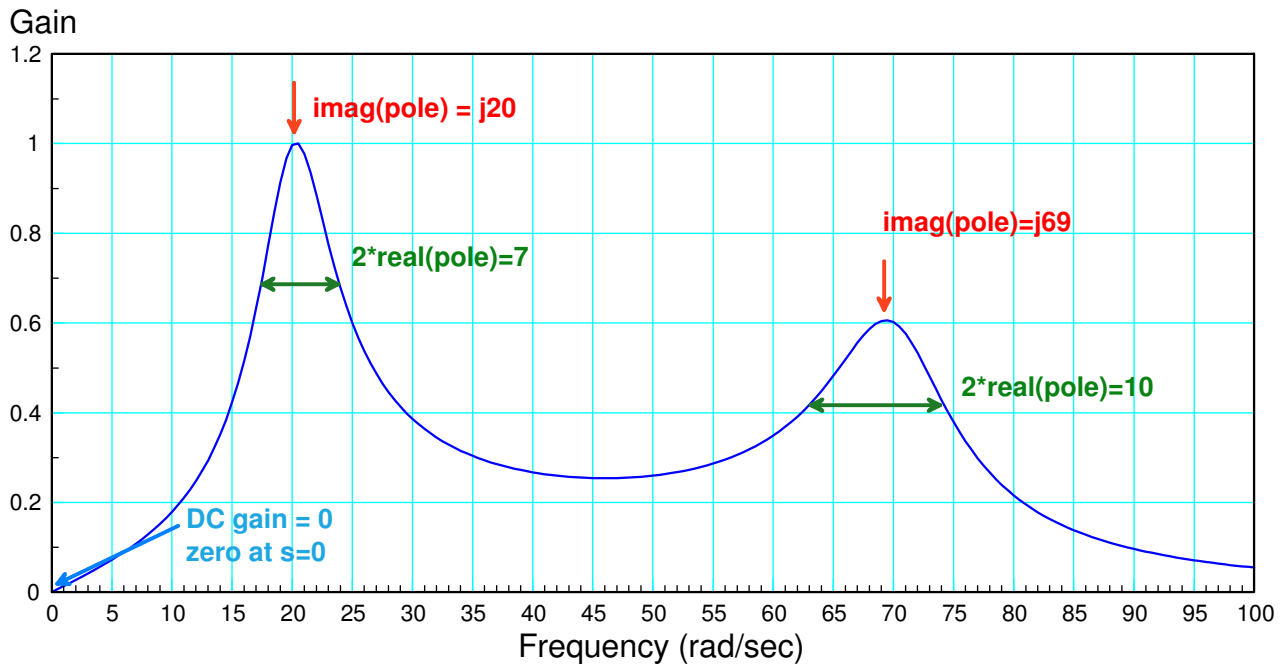
$$Y = -131.4 - j309.01$$

$$y(t) = -131.4\cos(2t) + 309.4\sin(2t)$$

The total answer is DC + AC

$$y(t) = 238.1 - 131.4\cos(2t) + 309.4\sin(2t)$$

6) Determine a filter, G(s), with the following gain vs. frequency



$$G(s) \approx \left(\frac{ks}{(s+3.5+j20)(s+3.5-j20)(s+5+j69)(s+5-j69)} \right)$$