ECE332 Sum 2016 Under Academic Security Until 2 Aug 2016 Quiz 6
(10 minutes)

[40 pts] **Find**: Develop and express the center frequency gain $|T(j\omega_o)|$ exclusively in terms of R_1, R_2, and/or C. Show your work!

$$T(s) = \frac{1/R_1C \quad s}{s^2 + \frac{2}{R_2C}s + \frac{1}{C^2R_1R_2}}$$

a $s = j\omega = j\omega_o$ $\quad T(j\omega_o) = \dfrac{\frac{1}{R_1C} j\omega_o}{\frac{2}{R_2C} j\omega_o}$

$$|T(j\omega_o)| = \frac{1}{R_1C} \cdot \frac{R_2C}{2} = \frac{R_2}{2R_1} = 10 \quad R_2 = 20 R_1$$

[10 pts] **Find**: Determine R_2 if $R_1 = 1\ k\Omega$. Assume you found $|T(j\omega_o)| = \frac{1}{2}\frac{R_2}{R_1} = \frac{1}{2\zeta^2}$ from above.

$$\frac{R_2}{R_1} = \frac{1}{\zeta^2} \quad R_1 = 1K \quad R_2 = \frac{1K}{\zeta^2}$$

$$\zeta = \sqrt{\frac{R_1}{R_2}} = \sqrt{\frac{R_1}{20R_1}} = \sqrt{0.05} = 0.223$$

[10 pts] **Find**: Determine C using R_1 and R_2 you found above. Assume you found $\omega_o = \frac{1}{C\sqrt{R_1R_2}}$.

$$C = \frac{1}{\omega_o\sqrt{R_1R_2}} = \frac{1}{\omega_o\sqrt{\frac{1M}{\zeta^2}}} = \frac{\zeta}{1K \cdot \omega_o}$$

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Name: Solution

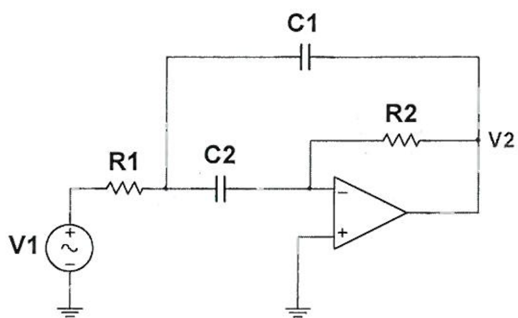
1. [100 pts] **Given**: The Bandpass Sallen-Key topology below with the following requirements.

ω_o=10,000 rad·s^{-1} $|T(j\omega_o)| = 10$ V/V

Using Equal Capacitor method $T(s) = \dfrac{\frac{1}{R_1C}s}{s^2+\frac{2}{R_2C}s+\frac{1}{R_1R_2C^2}}$

$$\frac{\frac{1}{R_1\cancel{C}}}{\frac{2}{R_2\cancel{C}}} = 10$$

$$\frac{R_2}{R_1} = 20$$



[20 pts] **Find**: Develop and express ω_o exclusively in terms of R_1, R_2, and/or C using $T(j\omega)$ above. Show your work!

$$s^2 + 2\zeta\omega_0 + \omega_0^2 = s^2 + \frac{2}{R_2C}s + \frac{1}{R_1R_2C^2}$$

$$|T(j\omega_0)| = \frac{\frac{1}{R_1C}j\omega_0}{(j\omega_0)^2 + \frac{2}{R_2C}j\omega_0 + \frac{1}{R_1R_2C^2}}$$

$$\Rightarrow \omega_0^2 = \frac{1}{R_1R_2C^2} \qquad \omega_0 = \frac{1}{\sqrt{R_1R_2}\cdot C}$$

$$-\omega_0^2 + \frac{1}{R_2R_1C^2} = 0 \qquad \omega_0 = \frac{1}{\sqrt{R_1R_2}\cdot C}$$

[20 pts] **Find**: Develop and express ζ exclusively in terms of R_1, R_2, and/or C using $T(j\omega)$ above. Show your work!

$$2\zeta\omega_0 = \frac{2}{R_2C} \qquad \zeta\frac{1}{\sqrt{R_1R_2}\cdot C} = \frac{1}{R_2C}$$

$$\zeta = \frac{\sqrt{R_1R_2}}{R_2} = \sqrt{\frac{R_1}{R_2}} \qquad \zeta^2 = \frac{R_1}{R_2}$$