SK Design Example

- **Design a 2nd order highpass filter with:**

$$d = \sqrt{2}$$
$$\omega_n = 10^3\ rad/s$$

- **The generic transfer function of a highpass 2nd order filter is:**

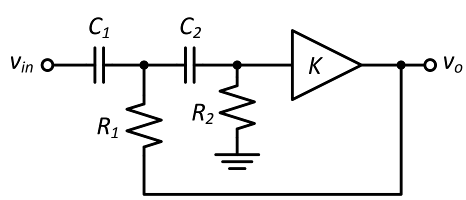
$$H(s) = \frac{K(s/\omega_n)^2}{1 + d(s/\omega_n) + (s/\omega_n)^2}$$

  - **This filter has a passband gain of K**

- **Next we go through 4 design decisions you have to make, and calculations for parameters that result from those decisions**

SK Design Example

- **Use circuit #3 from the SK paper**



❖ **Decision 1: Choose that we want to <u>specify</u> γ and T_1, then <u>solve</u> for ρ and T_2**

  - **This implies we're using Formula Group 1 in SK paper**

SK Design Example

- **Decision 2: Choose C_1 equals C_2**

$$C_1 = C_2 \qquad \gamma = \frac{C_2}{C_1} = 1$$

- **Next step: find minimum allowed amp gain: K_{min}**
  - **Equation from Formula Group 1 is SK**

$$K_{\min} = \frac{4(1+\gamma) - d^2}{4(1+\gamma)} = \frac{4(1+1) - 2}{4(1+1)} = \frac{3}{4}$$

- **Decision 3: Choose value for K greater or equal to K_{min}**

$$K \geq K_{\min} \qquad K = 1$$

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SK Design Example

- **Next step: Solve for the value of T_1**
  - **From the SK paper, Formula Group 1**

$$d = \frac{1-K}{T_1} + T_1(1+\gamma)$$

  - **We already have K = 1, γ = 1, and d = sqrt(2) Plugging in…**

$$d = \frac{1-1}{T_1} + T_1(1+1) = \sqrt{2} \qquad T_1 = \frac{\sqrt{2}}{2} = \frac{1}{\sqrt{2}} \approx 0.7$$

- **Next step: Solve for the value for T_2**

$$T_2 = \frac{1}{T_1} = \sqrt{2} \approx 1.4$$

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SK Design Example

- **Summary so far…**

$$\gamma = 1 \qquad T_1 \approx 0.7$$
$$K = 1 \qquad T_2 \approx 1.4$$

- **Next step: Choose actual component values**
  - **We'll need to know ω_n to un-normalize**
  - **ω_n was given with the filter specifications (slide 1)**

$$\omega_n = 10^3\ rad/s$$

SK Design Example

❖ **Decision 4: Choose a value for C_1, then $C_2 = C_1$ since $\gamma = 1$**

$$C_1' = C_2' = 1\mu F$$

- **Next step: solve for rest of the component values**
  - **Starting with T_1**

$$T_1 = R_1' C_1' \omega_n = 0.7 \qquad R_1' = \frac{0.7}{1\mu F \cdot 10^3} = 700\Omega$$

  - **Next, T_2**

$$T_2 = R_2' C_2' \omega_n = 1.4 \qquad R_2' = 1.4k\Omega$$

SK Design Example

- **Final circuit**