

Filters and crossovers

Solutions · step by step

- 01**
1. $RC = 0.0001 \text{ s}$.
 2. $\text{Cutoff} = 1/(2\pi RC)$.
 3. $\text{Cutoff} = 1591.55 \text{ Hz}$.

$$f_c = \frac{1}{2\pi RC} = 1591.55 \text{ Hz}$$

- 02**
1. $\text{Ratio} = 1/\sqrt{2} = 0.7071$.
 2. $20 \log_{10}(0.7071)$.
 3. Result: -3.01 dB .

$$|H(f_c)| = \frac{1}{\sqrt{2}}; \quad 20 \log_{10} |H| = -3.01 \text{ dB}$$

- 03**
1. Frequency ratio: 10.
 2. $\text{Ratio} = 1/\sqrt{1 + 10^2}$.
 3. 0.0995 or -20.04 dB .

$$|H| = \frac{1}{\sqrt{101}} = 0.0995$$

- 04**
1. Cutoff is inversely proportional to C.
 2. Double capacitance.
 3. 100 nF becomes 200 nF.

$$f_c \propto \frac{1}{C}$$

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- 05**
1. Rearrange for C.
 2. $C = 1/(2\pi \cdot 100 \cdot 10000)$.
 3. $C = 159.15 \text{ nF}$.

$$C = \frac{1}{2\pi f_c R} = 159.15 \text{ nF}$$

- 06**
1. At cutoff, inductive reactance equals R.
 2. $L = R/(2\pi f_c)$.
 3. $L = 0.637 \text{ mH}$.

$$L = \frac{R}{2\pi \cdot 2000} = 0.637 \text{ mH}$$

- 07**
1. At cutoff, capacitive reactance magnitude equals R.
 2. $C = 1/(2\pi f_c R)$.
 3. $C = 9.947 \text{ }\mu\text{F}$.

$$C = \frac{1}{2\pi \cdot 2000 \cdot 8} = 9.947 \text{ }\mu\text{F}$$

- 08**
1. Cutoff is inversely proportional to R.
 2. New cutoff = $2000 \cdot 8/6$.
 3. Result: 2666.67 Hz.

$$f_{c, \text{new}} = 2000 \frac{8}{6} = 2666.67 \text{ Hz}$$

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- 09**
1. Impedance varies with frequency and is complex.
 2. The acoustic driver response also contributes.
 3. Include measured magnitude, phase and mounting geometry.

- 10**
1. Convert dB back to voltage ratio.
 2. $k = 10^{(-6/20)}$.
 3. $k = 0.5012$.

$$k = 10^{-6/20} = 0.5012$$

- 11**
1. Series $R = R(1-k) = 4 \Omega$.
 2. Shunt $R = Rk/(1-k) = 8 \Omega$.
 3. 8Ω parallel $8 \Omega = 4 \Omega$, plus $4 \Omega = 8 \Omega$.

$$R_s = R(1 - k); \quad R_p = \frac{Rk}{1 - k}$$

- 12**
1. Source current = $8/8 = 1 \text{ A}$.
 2. Series resistor: 4 W ; output: 4 V .
 3. Load and shunt resistor each dissipate 2 W .

$$P_s = 4 \text{ W}; \quad P_p = P_L = \frac{4^2}{8} = 2 \text{ W}$$

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- 13**
1. Zobel $R = R_e = 6 \Omega$.
 2. Zobel $C = L_e/R_e^2$.
 3. $C = 16.67 \mu F$. This model has no mechanical resonance.

$$C_Z = \frac{L_e}{R_e^2} = 16.67 \mu F$$

- 14**
1. First, impedance compensation.
 2. This can make the preceding crossover behave more predictably.
 3. Acoustic flatness is not guaranteed.

- 15**
1. $L \cdot C = 10^{-8}$.
 2. Square root = 0.0001.
 3. Resonance = 1591.55 Hz.

$$f_0 = \frac{1}{2\pi\sqrt{LC}} = 1591.55 \text{ Hz}$$

- 16**
1. Resonance is inversely proportional to square root of C.
 2. Quadruple C for half frequency.
 3. New $C = 40 \mu F$.

$$C_{new} = 4C = 40 \mu F$$

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- 17**
1. Correction is -4 dB.
 2. Ratio = $10^{(-4/20)}$.
 3. Ratio = 0.6310; bandwidth and phase must also fit.

$$k = 10^{-4/20} = 0.6310$$

- 18**
1. Cancellation remains.
 2. More drive increases excursion and power.
 3. First check polarity, delay, geometry and individual branches.

- 19**
1. Each branch has pressure ratio 0.5.
 2. Add in phase: $0.5 + 0.5 = 1$.
 3. Sum = 0 dB.

$$20\log_{10} (0.5 + 0.5) = 0 \text{ dB}$$

- 20**
1. Same measurement position and excitation.
 2. Measure branches and sum with timing preserved.
 3. Check impedance and multiple angles; use identical smoothing.