

SOLUTION



Lecture 36: Filters IV – Filter Design Problems

OBJECTIVES:

1. Demonstrate understanding by working filter design examples

READING

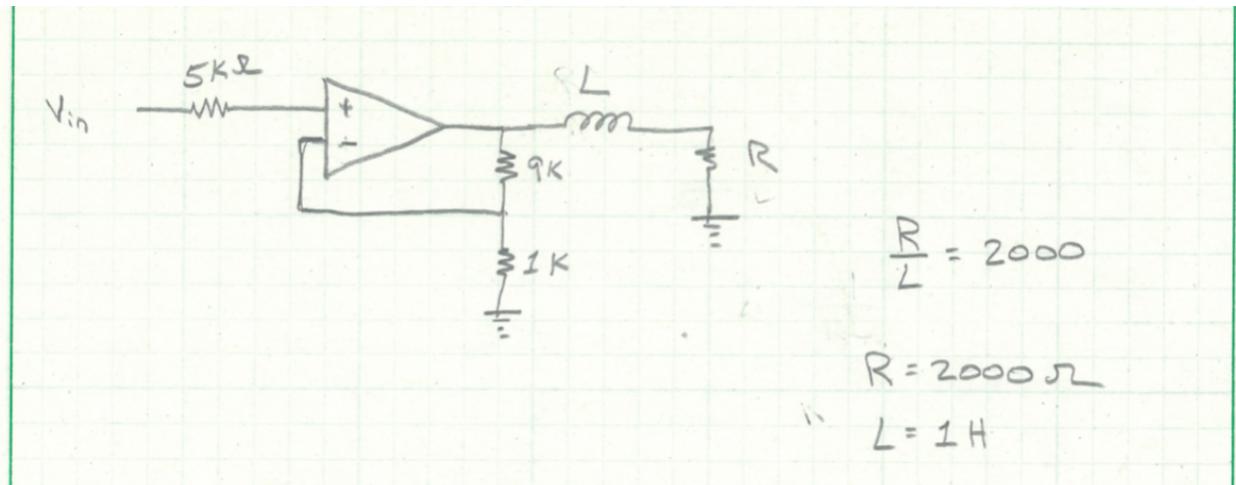
Required : Filters Handout (Available on Sharepoint), pgs 39–45

This lesson is dedicated to doing example problems (board work). Recommend you work on the board as I move around and help, but please copy the solution in your notes so you have access later.

1 Example 1 – Low Pass Filter

Given: We require a low-pass filter with a cut-off frequency of 2000 rad/sec and a passband gain of 20 dB. Additionally, the filter must connect to a source with a Thevenin resistance of $5\text{ k}\Omega$.

Find: Design a circuit that meets the specifications.



SOLUTION

$$dB \rightarrow GAIN$$
$$20 = 20 \log(K)$$
$$\log K = 1$$
$$K = 10$$
$$H(j\omega) = -\frac{R_F}{R_i} \left[\frac{\frac{1}{RC}}{j\omega + \frac{1}{RC}} \right]$$
$$\omega_c = \frac{1}{R_F C} = 2000$$
$$C = 0.1 \mu F$$
$$R_F = 5 K \Omega$$
$$\therefore R_i = 500 \Omega$$

SOLUTION

2 Example 2 – High Pass Filter

Given: We require a high-pass filter with a cut-off frequency of 318.31 Hz and a passband gain of ± 15 . Additionally, the filter must connect to a load with a resistance of $10 \text{ k}\Omega$.

Find: Design a circuit that meets the specifications.

$$\omega = 2\pi f = 2\pi (318.31) = 2000 \text{ RAD/s}$$

$$K = \pm 15$$

$$\frac{1}{CR_F} = 2000$$

$$R_F = 5 \text{ k}\Omega$$

$$C = 0.1 \mu\text{F}$$

$$\frac{R_A + R_B}{R_B} = 15$$

$$R_A = 14 \text{ k}\Omega$$

$$R_B = 1 \text{ k}\Omega$$

(OR)

$$\frac{1}{R_1 C} = 2000$$

$$R_1 = 5 \text{ k}\Omega$$

$$C = 0.1 \mu\text{F}$$

$$\frac{R_F}{R_1} = 15$$

$$R_F = 7.5 \text{ k}\Omega$$

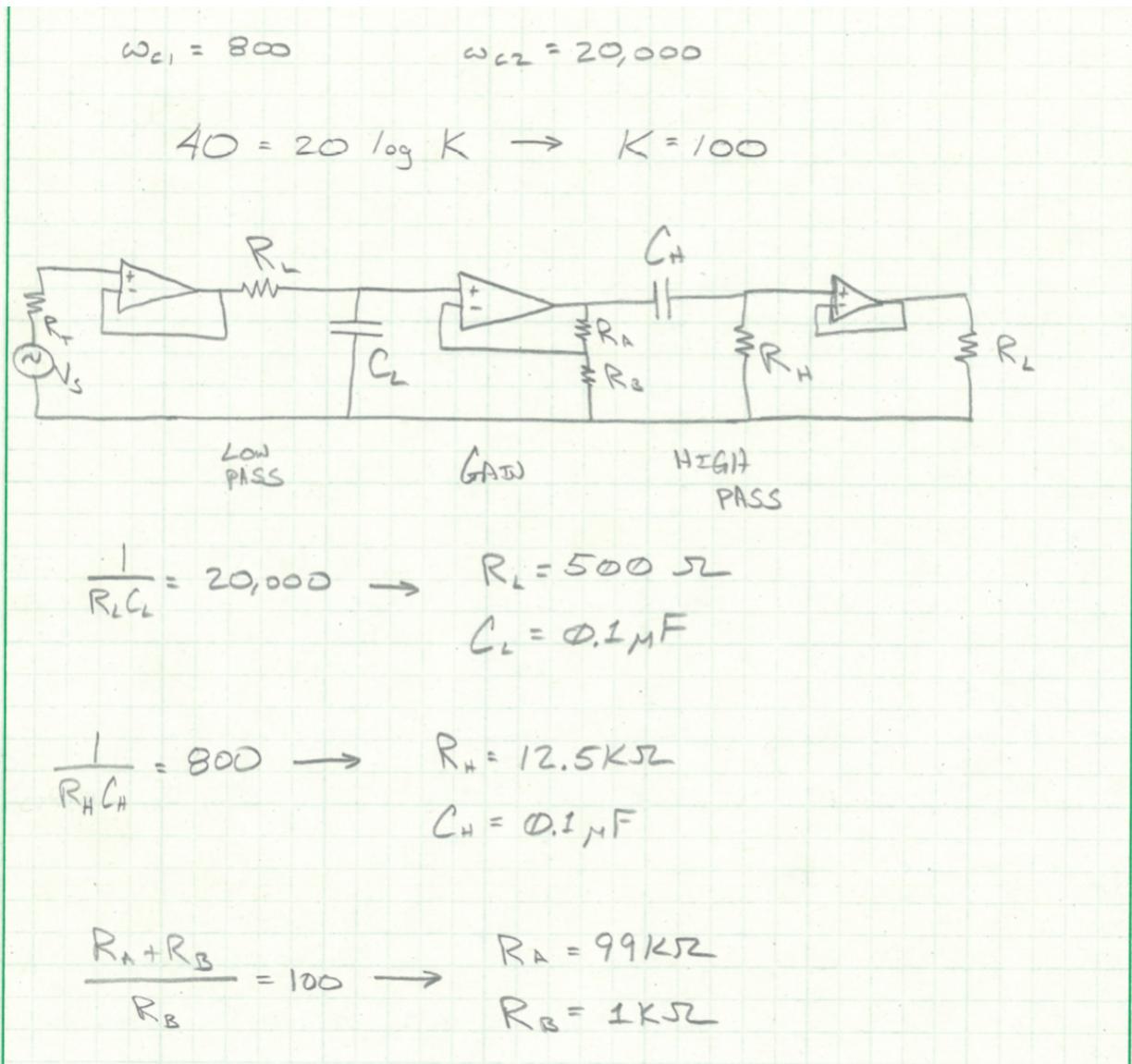
$$R_1 = 5 \text{ k}\Omega$$

SOLUTION

3 Example 3 – Band Pass Filter

Given: We require a band-pass filter with a low cut-off frequency of 800 rad/sec, a high cut-off frequency of 20000 rad/sec, and a passband gain of 40 dB. Additionally, the filter must connect to a source with a Thévenin resistance of $10 \text{ k}\Omega$ and a load with a resistance of $20 \text{ k}\Omega$.

Find: Design a circuit that meets the requirements.



SOLUTION

4 Example 4 – Band Reject Filter

Given: We require a band-reject filter with a low cut-off frequency of 800 rad/sec, a high cut-off frequency of 20000 rad/sec, and a passband gain of ± 100 .

Find: Design a circuit that meets the requirements.

