ENGR-241 Passive Filters Lab

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March 24, 2021

Overview

For this lab we designed and constructed high and low pass filter circuits with RC components. We designed each circuit with a cutoff frequency of 10 KHz and used the signal generator to produce a 2V p-p sinusoidal waveform as the voltage source. We then swept the frequency between 1KHz and 100KHz and calculated the expected output voltage for given frequencies.

Circuit Diagrams

Calculations

The calculations for this circuit were performed by finding the transfer function for three different frequencies between 1KHz and 100KHz and the calculated value along with the given input function to determine the expected output voltage of our high and low pass filters.

1. Calculate the transfer of the given LPF circuit.

$$H(j\omega) = \frac{\frac{1}{RC}}{j\omega + \frac{1}{RC}}$$

$\omega_1 = 1KHz \cdot 2\pi = 2,000\pi \, rad/s$
$\omega_2 = 10KHz \cdot 2\pi = 20,000\pi \, rad/s$
$\omega_3 = 100KHz \cdot 2\pi = 200,000\pi \, rad/s$

$$H(j\omega_1) = \frac{\frac{1}{1050 \cdot 15.1 \cdot 10^{-9}}}{j \cdot 2000\pi + \frac{1}{1050 \cdot 15.1 \cdot 10^{-9}}}$$
$$H(j\omega_1) = 0.995075 \angle -5.6890°$$

$$H(j\omega_2) = \frac{\frac{1}{1050 \cdot 15.1 \cdot 10^{-9}}}{j \cdot 20,000\pi + \frac{1}{1050 \cdot 15.1 \cdot 10^{-9}}}$$
$$H(j\omega_2) = 0.708452 \angle -44.8909°$$

$$H(j\omega_3) = \frac{\frac{1}{1050 \cdot 15.1 \cdot 10^{-9}}}{j \cdot 200,000\pi + \frac{1}{1050 \cdot 15.1 \cdot 10^{-9}}}$$
$$H(j\omega_3) = 0.09988 \angle -84.2678°$$

2. Use these values to construct the time domain function for each frequency.

$V_{o(1)} = 0.995075 cos(2000\pi t - 5.68903) V$
$V_{o(2)} = 0.70845 cos(20,000\pi t - 44.8909) V$
$V_{o(3)} = 0.09988 cos(200,000\pi t - 84.2678) V$

3. Calculate the transfer of the given HPF circuit.

$$H(j\omega) = \frac{j\omega}{j\omega + \frac{1}{RC}}$$

$\omega_1 = 1 KHz \cdot 2\pi = 2,000\pi \, rad/s$
$\omega_2 = 10 KHz \cdot 2\pi = 20,000\pi \, rad/s$
$\omega_3 = 100 KHz \cdot 2\pi = 200,000\pi \, rad/s$

$$H(j\omega_1) = \frac{j \cdot 2000\pi}{j \cdot 2000\pi + \frac{1}{1050 \cdot 15.1 \cdot 10^{-9}}}$$
$$H(j\omega_1) = 0.099129\angle 84.311°$$

$$H(j\omega_2) = \frac{j \cdot 20,000\pi}{j \cdot 20,000\pi + \frac{1}{1050 \cdot 15.1 \cdot 10^{-9}}}$$
$$H(j\omega_2) = 0.705759\angle 45.1091°$$

$$H(j\omega_3) = \frac{j \cdot 200,000\pi}{j \cdot 200,000\pi + \frac{1}{1050 \cdot 15.1 \cdot 10^{-9}}}$$
$$H(j\omega_3) = 0.995\angle 5.73224°$$

2. Use these values to construct the time domain function for each frequency.

$V_{o(1)} = 0.099129 cos(2000\pi t + 84.311) V$
$V_{o(2)} = 0.705759 cos(20,000\pi t + 45.1091) V$
$V_{o(3)} = 0.995 cos(200,000\pi t + 5.73224) V$