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Lab: (Monday 7-10PM A55)

Lab Room: WLH-2215

ECE 35 Lab 5 Report

**Introduction**

This lab is an introduction to filters. We used MATLAB to help us construct filters. This class offers great exposure to classes about circuits and systems and linear electronic systems. Those classes will study filters in detail. The band-pass filter will be used to demonstrate how a circuit can hone in on a specific (band) frequency and reject everything else. It will be composed of a high-pass and a low-pass cascaded together, or connected in series. A high-pass will block low frequencies and pass the higher frequency signals. The low-pass will block high frequencies and pass the lower frequency signals. The band-pass, in general, has the high-pass come first so large ambient noise does not propagate far into the system. In this lab we will design signal transmissions with -3dB frequencies and test the RC high-pass and low-pass filters. We have to do this then test the direct bandpass and buffered bandpass. We analyze the effects of these.

**Procedure**

**Prelab**

* For the prelab, we are required to analyze the Hboth bandpass circuit.
* First we have to find the capacitance by using the -3dB frequencies.
* It is simple, just use the formula and solve for C.
* Next we move on to the circuit, we use whatever laws we know to solve for Vout/Vin
* Download the bandpass.m and with our answer we have to edit this one line of code
  + %hboth = j\*w\*r2\*c2./((1 + j\*w\*r2\*c2).\*(1 + j\*w\*r1\*c1) + ????);
* Delete the % for the comment and add the ???? in from our calculations
* We should be able to get a graph print out.

**Lab Procedure**

* We have to build the circuit that is provided for us and test if it works.
* The first two parts, we build the upper two circuits which consist of the high pass and the low pass.
* We have to test to see if it works. After we have verified it we can move on.
* The second part is for the direct bandpass.
* First we have to change the bandpass.m program to fit our capacitance values.
* We used two capacitors in parallel to make our capacitance.
* Moving on, the direct bandpass is made without the operational amplifier. This will be analyzed with our --- or dotted graph from our MATLAB program.
* We are to use the oscilloscope to measure 7 different frequencies to find 7 different Vout/Vin values.
* We have to check if this matches the MATLAB graph that we produced.
* After this is set, we can move on to the buffered bandpass.
* This is the same as the steps above except we install an op-amp to buffer the circuit.
* We use the solid line this time to compare our points to.
* After this is complete the lab is done.

**Clean Up**

* Clean up and put away all of the equipment.

**Analysis and Tables**

**Table 1. Direct Bandpass**

|  |  |  |
| --- | --- | --- |
| **Point** | **Frequency (KHz)** | **Vout/Vin** |
| **1** | 0.1 | 0.328 |
| **2** | 0.5 | 0.784 |
| **3** | 1 | 0.864 |
| **4** | 2 | 0.888 |
| **5** | 5 | 0.864 |
| **6** | 10 | 0.800 |
| **7** | 20 | 0.672 |

**Table 2. Buffer Bandpass**

|  |  |  |
| --- | --- | --- |
| **Point** | **Frequency(kHz)** | **Vout/Vin** |
| **1** | 0.1 | 0.336 |
| **2** | 0.5 | 0.880 |
| **3** | 1 | 0.976 |
| **4** | 2 | 1.00 |
| **5** | 5 | 0.992 |
| **6** | 10 | 0.904 |
| **7** | 20 | 0.712 |

**Analysis**

During our lab session, we examined the low-pass (LP), high-pass (HP), band-pass, and buffer-pass filters. A LP filter can reshape, modify or reject high frequency and only allows low frequency to its cut-off frequency. A HP filter only allows cut-off frequency to high frequency to pass while blocking the low frequency. The band-pass filter allows the signal to fall within a range of frequency while rejecting both high and low frequency. Finally the buffer pass acts the same way as the band-pass, and further prevents any interaction between the circuits so their transfer functions simply multiply ideally. During our prelab and lab process, we use Matlab to print and plot the transfer function which allows us to analyse the relationship between the frequency and the ratio of Vin and Vout for bandpass and buffer-pass filters. With regards to the bandpass equation, the low-pass and high-pass are separate AC circuits. Therefore, it is not permissible to multiply the low-pass and the high-pass expressions. With regards to the buffer pass equation, since the functionality of buffer pass filter is to prevent any interaction between the circuits so the low and high pass transfer functions can simply multiply ideally, we simply just multiply LP and HP together using a buffer Op-Amp. Finally, from the printout, we observed that the max transfer function of the buffer-pass filter is larger than the band-pass filter. This is because from the circuit, the ratio of Vout over Vin is larger for the buffer-pass circuit which is influenced by the circuit design. On the one hand, band-pass and buffer-pass both permit the signals to fall to its cut-off frequency while rejecting both high and low frequency. On the other hand, buffer-pass is different from band-pass in the way that it connects the LP and HP together without disturbing their transfer functions via an Op-Amp.

**Conclusion**

In the end of the lab, we were able to successfully build the bandpass filter and analyze both of the direct and buffered bandpass. We also successfully tested the low pass and high pass separately. These were pretty simple circuits to build. Ultimately, we were able to use node equations to solve for the formula to solve for both hp + lp equation. Conclusively, this experiment can be considered a success as we successfully learned about bandpass filters and their characteristics and properties.