Linear Network Analysis and Synthesis. Lab 2, May 2024

Session 2

Design and characterization of a bandpass filter. (35%)

FULL NAME: *insert here your full name*
DATE and TIME: *insert here date and starting time*
ROOM: *insert here the room where you do the lab*

Insert the screenshots with each of the setups used in your measurements. Always give reasons for the validity of the results obtained, and make any comments you consider relevant.

IMPORTANT: It is recommended to always use a `Time step size` at least 100 times lower than the minimum period of the signals you are measuring.

NOTE: If the measurements taken in the lab do not correspond to the theoretical results (obtained in the preparatory work or during the lab session), you must either find the error in the theoretical approach, or find the error in the measurement, or try to explain the discrepancy.

1. **AMPLITUDE response of the designed bandpass filter [10%]**
Obtain the **modulus** of the frequency response of the designed bandpass filter. To do this you must make measurements with the circuit simulator. The frequencies chosen to characterize the filter should allow to verify that the filter response in amplitude meets the specifications. Compare the obtained measurements with the expected theoretical result.

Insert screenshot(s) here

Results, explanations and comments

Table/graph of measurements and theoretical values

Optional: Insert link to the designed circuit in Falstad (this can be done in all answers)

2. **PHASE response of the designed bandpass filter [10%]**
Now make the necessary measurements to obtain the **phase** response, but only of the passband (the center of the passband and two more frequency points are enough).

Insert screenshot(s) here

Results, explanations and comments

Table/graph of measurements and theoretical values

3. **Group delay [5%].**
Estimate the group delay at the center frequency of the bandpass filter.

Explain the estimation/measurement method

Result:

4. **Effect of noise WITHOUT the bandpass filter [5%]**
Study the effect of adding noise to the FSK signal in the system with the low pass and high pass filters that you designed in the first session, but **without** the band-pass filter you just designed (complete the circuit for this link):

- Determine, by progressively increasing the amplitude of the noise, what is the maximum noise level at which the signal is no longer correctly detected at the node `RX signal`.

Insert screenshot(s) here

Result and explanation/comment

- Suppose now that you use the envelope of the output of the high pass filter to determine the symbol that arrives at it (node `P1`). What would be the maximum noise level at which it would be possible to recover, with few errors, the transmitted data?

Insert screenshot(s) here

Result and explanation/comment

- Suppose now that you use the envelope of the output of the low-pass filter to determine the symbol that arrives at it (node `P2`). What would be the maximum noise level at which it would be possible to recover, with few errors, the transmitted data?

Insert screenshot(s) here

Result and explanation/comment

NOTE: Try to explain the different noise levels obtained

5. **Effect of noise WITH the bandpass filter [5%]**
Now add the band pass filter to the system (complete the circuit of this link):

- What is the delay of the received data signal `RX signal` with respect to the original `binary signal`? Relate the result with the phase response of the bandpass filter studied in sections 2 and 3.

Insert screenshot(s) here

Results and explanations/comments

- Repeat section 4 and compare the results. Draw conclusions about the effectiveness of the bandpass filter in limiting the effect of noise.

Insert screenshot(s) here

Results and explanations/comments