ECE 351 DSP: Assignment 2

Instructor: Manuj Mukherjee

Total: 30 points

Submission deadline: 10:00 AM 21.10.2022

Instruction: You can write the codes in either Python or MATLAB, though Python is preferred. Make sure to run and check your code before submitting. For the theoretical parts, you can directly use any formula taught in class.

1) Consider the following filter: $H(z) = \frac{3\sqrt{2}-6z^{-1}+3\sqrt{2}z^{-2}}{4\sqrt{2}-6z^{-1}+2\sqrt{2}z^{-2}}$.

   a) Write a code to plot the magnitude response of the filter for $\omega \in [0, \pi]$.

   b) What kind of a filter is it?

   c) Find the 3dB bandwidth of the filter. What is its centre/notch frequency in case it is a bandpass/notch filter? [You should not give approximate results by reading of the plot. You need to give exact results by on-paper calculations using what was taught in class.]

[4+1+5=10 points]

2) Consider the system characterised by the difference equation $y[n] = 3y[n-1] + x[n]$.

   a) Is this system stable?

   b) If unstable, construct a bounded input (not necessarily causal) which leads to unbounded output.

[1+4=5 points]

3) Consider an all-pass filter with two poles at 0.5 and -0.75.

   a) What is its transfer function $H(z)$?

   b) Write a code to plot the unwrapped phase and group delay of this all-pass filter.

[2+3=5 points]

4) Consider the system with impulse response $h[n] = (\frac{1}{4})^n \cos(\frac{\pi}{4}n)u[n]$.

a) Draw a diagram showing the implementation of this system using a finite number of delays, adders, and multipliers.

b) Write a code to plot the frequency response of this system for $\omega \in [0, \pi]$.

c) Calculate the system output when the input is $x[n] = (\frac{1}{4})^n u[n]$.

[3+3+4=10 points]