Digital Signal Processing

WS 2017 Lab Sheet 5

Due date: 02.12.2017.

Exercise 1: Difference equation analysis — 18 Points

Consider an LTI system defined by the difference equation

$$y[n] = -2x[n] + 4x[n-1] - 2x[n-2].$$

a. Determine the impulse response of this system. (3)

b. Determine the frequency response of this system. Express your answer in the form

$$H(e^{jw}) = A(e^{jw})e^{-jwn_d},$$

where $A(e^{jw})$ is a real function of ω. Explicitly specify $A(e^{jw})$ and the delay n_d of this system. (4)

c. Use matlab to plot the magnitude and the phase of this sytem. (3)

d. Suppose that the input to the system is

$$x_1[n] = 1 + e^{j0.5\pi n} \quad -\infty < n < \infty.$$

Using the frequency response to determine the corresponding output $y_1[n]$. (3)

e. Now suppose that the input to the system is

$$x_2[n] = (1 + e^{j0.5\pi n})u[n] \quad -\infty < n < \infty.$$

Use the defining differene equation or discrete convolution to determine the corresponding output $y_2[n]$ for $-\infty < n < \infty$. Compare $y_1[n]$ and $y_2[n]$. They should be equal for certain values of n. Over what range of values of n are they equal? (5)

Exercise 2: Discrete Time Fourier Transform I — 12 Points

Find the DTFT of the following sequences:

a. $x[n] = \alpha^n \sin(n\omega_0)\, u[n] \quad \text{for } |\alpha| < 1$ (4)

b. $x[n] = \begin{cases} \left(\frac{1}{2}\right)^n & \text{if } n = 0, 2, 4, \ldots \\ 0 & \text{else} \end{cases}$ (4)

c. $x[n] = 3\delta[n] + 2(\delta[n-1] + \delta[n-5]) + 2(\delta[n-2] + \delta[n-4])$ **(4)**

Maximal score: **30 Points**