EE2800 - Digital Signal Processing
Electrical Engineering
IIT Hyderabad

Homework-2

Note

* Plagiarism is strictly prohibited
* Late submissions will be penalized with a factor of 0.5 per each hour
* Deadline will not be extended under any circumstances

1. Comment on the causality and stability of the systems with following unit sample responses.

   (a) $h[n] = \delta[n - d]$ where d is an integer

   (b) $h[n] = u[n] - u[n - N]$

   (c) $h[n] = \frac{1}{2N+1} \sum_{k=-N}^{N} \delta[n - k]$

   (d) $h[n] = a^n u[-n]$, Derive condition on $a \in \mathbb{R}$ for stability

   (e) $h[n] = \sum_{k=-\infty}^{n} \delta[k]$

   ($N \in \mathbb{Z}^+$)

2. Recall the condition on the unit sample response for stability

$$\sum_{k=-\infty}^{\infty} |h[k]| < \infty$$

   Show that the above is a sufficient and necessary condition for stability with appropriate examples.

3. Compute and sketch the LTI system output for the following input and unit sample response sequence pairs

   (a) $x[n] = [4, 2, \underline{2}, 3, 1, 6]$ $h[n] = [\underline{1}, 0, 3, 1, 5]$

   (b) $x[n] = [\underline{-1}, -1, 0, 0, 1, 1, 0, 0, -1, -1]$ $h[n] = [\underline{\frac{1}{3}}, \frac{1}{3}, \frac{1}{3}]$

4. Compute the LTI system output($y_*[n]$) for the following input and unit sample response pairs.

   (a) $x_1[n] = a^n u[n]$, $|a| < 1$; $h_1[n] = u[n] - u[n - M]$

(b) $x_2[n] = a^n u[n]$, $|a| < 1$; $h_2[n] = u[n + M] - u[n]$

(c) $x_3[n] = a^n u[n]$, $|a| < 1$; $h_3[n] = u[n + M] - u[n - M]$

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How do you relate the outputs $y_1[n]$, $y_2[n]$ and $y_3[n]$? ($M \in Z^+$)

5. What is an eigenfunction ? Check whether e^{sn} is eigenfunction of an LTI system with unit sample response $h[n]$? If so, derive the eigenvalues?

6. Compute and sketch the magnitude and phase response for the LTI systems with the following unit sample responses

(a) $h[n] = e^{j\omega_0 n}$

(b) $h[n] = a^n u[n - 10]$, $|a| < 1$

(Z^+) 0 else

(c) $h[n] =$

1 $0 \le n \le M$($\in$

(d) $h[n] = \frac{sin(\omega_c n)}{\pi n}$

7. For an LTI system with input and unit sample response $x[n]$

$$= -2 + 3cos(\frac{\pi n}{4} + \frac{\pi}{3}) + 10cos(3\pi n$$

$$4 - \frac{\pi}{5})$$

$$h[n] = 3\delta[n] + 2\delta[n - 1] + \delta[n - 3]$$

(a) Compute freuqnecy response $H(e^{j\omega})$

(b) Sketch the magnitude($|H(e^{j\omega})|$) and phase($\angle H(e^{j\omega})$) response

(c) Compute the system output $y[n]$