Faculty of Computers and Artificial Intelligence

CSx25: Digital Signal Processing
NCS224: Signals and Systems

Assignment no 02: Chapter 2

Note: You can check the exercises after the book Chapter.
In our assignment, we are using the first edition of "Signals and Systems: A MATLAB Integrated Approach" By Oktay Alkin.

Problems

2.1. A number of systems are specified below in terms of their input-output relationships.

For each case, **determine** if the system is linear and/or time-invariant.

a. $y(t) = |x(t)| + x(t)$
b. $y(t) = t\, x(t)$
c. $y(t) = e^{-t}\, x(t)$
d. $y(t) = \int_{-\infty}^{t} x(\lambda)\, d\lambda$

2.2. Consider the cascade combination of two systems shown in Fig. P.2.2(a).

Figure P. 2.2

a. Let the input-output relationships of the two subsystems be given as

$$\text{Sys}_1\{x(t)\} = 3\,x(t) \quad \text{and} \quad \text{Sys}_2\{w(t)\} = w(t-2)$$

Write the relationship between $x(t)$ and $y(t)$.

b. Let the order of the two subsystems be changed as shown in Fig. P.2.2(b).

Write the relationship between $x(t)$ and $\bar{y}(t)$.

Does changing the order of two subsystems change the overall input-output relationship of the system?

2.3. Repeat Problem 2.2 with the following sets of subsystems:

b. $\text{Sys}_1\{x(t)\} = 3\,x(t) \quad \text{and} \quad \text{Sys}_2\{w(t)\} = w(t) + 5$

2.22. Using the convolution integral, **prove** each of the relationships below:

a. $x(t) * \delta(t) = x(t)$

b. $x(t) * \delta(t - t_0) = x(t - t_0)$

2.23. The impulse response of a CTLTI system is

$$h(t) = \delta(t) - \delta(t-1)$$

Determine sketch the response of this system to the triangular waveform shown in Fig. P.2.23.

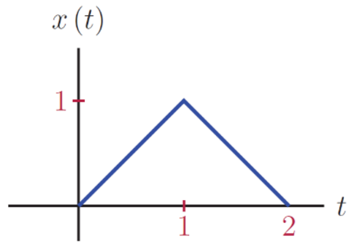

Figure P. 2.23

2.26. For each pair of signals $x(t)$ and $h(t)$ given below, find the convolution $y(t) = x(t)*h(t)$. In each case **sketch** the signals involved in the convolution integral and determine proper integration limits.

- **a.** $x(t) = u(t)$, $h(t) = e^{-2t}\,u(t)$
- **c.** $x(t) = u(t-2)$, $h(t) = e^{-2t}\,u(t)$
- **e.** $x(t) = e^{-t}\,u(t)$, $h(t) = e^{-2t}\,u(t)$

2.30. The system shown in Fig. P.2.30 represents addition of echos to the signal $x(t)$:

$$y(t) = x(t) + \alpha_1\,x(t-\tau_1) + \alpha_2\,x(t-\tau_2)$$

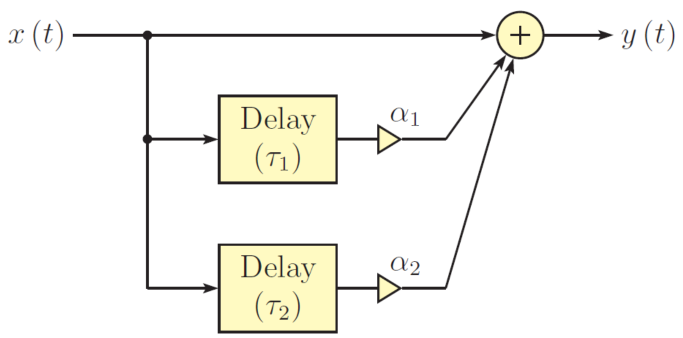

Figure P. 2.30

Comment on the system's

- **a.** Linearity
- **b.** Time invariance
- **c.** Causality
- **d.** Stability

2.31. For each system described below, **determine** if the system is causal and/or stable.

a. $y(t) = \text{Sys}\{x(t)\} = \int_{-\infty}^{t} x(\lambda)\, d\lambda$

b. $y(t) = \text{Sys}\{x(t)\} = \int_{t-T}^{t} x(\lambda)\, d\lambda\,, \qquad T > 0$

c. $y(t) = \text{Sys}\{x(t)\} = \int_{t-T}^{t+T} x(\lambda)\, d\lambda\,, \qquad T > 0$