INDIAN INSTITUTE OF TECHNOLOGY ROPAR
DEPARTMENT OF ELECTRICAL ENGINEERING
EEL201: SIGNALS AND SYSTEMS
TUTORIAL SHEET - 2

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1. Determine which of these properties {1. Static/Dynamic; 2. Causal/Non-Causal; 3. Linear/Non-Linear; 4. Stable/Unstable; 5. Time Invariant/Time Varying} for each of the following continuous-time systems. Justify your answers. In each example, y(t) denotes the system output and x(t) is the system input.

   (a) $y(t) = x(t-2) + x(2-t)$ (b) $y(t) = [\cos(3t)]x(t)$ (c) $y(t) = x(t/3)$

   (d) $y(t) = \int_{-\infty}^{2t} x(\tau)d\tau$ (e) $y(t) = \begin{cases} 0, & t < 0 \\ x(t) + x(t-2), & t \geq 0 \end{cases}$ (f) $y(t) = \begin{cases} 0, & x(t) < 0 \\ x(t) + x(t-2), & x(t) \geq 0 \end{cases}$

   (g) $y(t) = \dfrac{dx(t)}{dt}$

2. Determine which of these properties {1. Static/Dynamic; 2. Causal/Non-Causal; 3. Linear/Non-Linear; 4. Stable/Unstable; 5. Time Invariant/Time Varying} for each of the following discrete-time systems. Justify your answers. In each example, y(n) denotes the system output and x(n) is the system input.

   (a) $y(n) = x(-n)$ (b) $y(n) = x(n-2) - 2x(n-8)$ (c) $y(n) = nx(n)$

   (d) $y(n) = Ev\{x(n-1)\}$ (e) $y(n) = x(4n+1)$ (f) $y(n) = \begin{cases} x(n), & n \geq 1 \\ 0, & n = 0 \\ x(n+1), & n \leq -1 \end{cases}$

   (g) $y(n) = \begin{cases} x(n), & n \geq 1 \\ 0, & n = 0 \\ x(n), & n \leq -1 \end{cases}$

3. Determine if each of the following systems is invertible. If it is, construct the inverse system. If it is not, find two input signals to the system that have the same output.

   (a) $y(t) = x(t-4)$ (b) $y(t) = \cos[x(t)]$ (c) $y[n] = nx[n]$ (d) $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$

   (e) $y(n) = \begin{cases} x(n-1), & n \geq 1 \\ 0, & n = 0 \\ x(n), & n \leq -1 \end{cases}$ (f) $y[n] = x[n]x[n-1]$ (g) $y[n] = x[l-n]$

(h) $y(t) = \int_{-\infty}^{t} e^{-(t-\tau)} x(\tau) d\tau$ (i) $y(t) = x(2t)$ (j) $y(n) = x(2n)$

(k) $y(t) = \begin{cases} x(n/2) & n = even \\ 0 & n = odd \end{cases}$

4. (a) Consider an LTI system whose response to the signal $x_1(t)$ in Figure 1 (a) is the signal $y_1(t)$ illustrated in Figure 1 (b). Determine and sketch carefully the response of the system to the input $x_2(t)$ depicted in Figure 1(c).
(b) Determine and sketch the response of the system considered in part (a) to the input $x_3(t)$ shown in Figure 1(d).

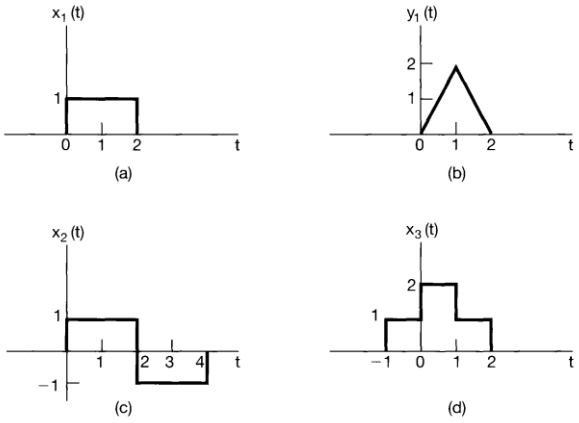

Figure 1

5. The following are the impulse responses of discrete-time LTI systems. Determine whether each system is causal and/or stable. Justify your answers.

(a) $h(n) = \left(\frac{1}{5}\right)^n u(n)$ (b) $h(n) = (0.8)^n u(n+2)$ (c) $h(n) = \left(\frac{1}{2}\right)^n u(-n)$

(d) $h(n) = (5)^n u(3-n)$ (e) $h(n) = \left(-\frac{1}{2}\right)^n u(n) + (1.01)^n u(n-1)$ (f) $h(n) = n\left(\frac{1}{3}\right)^n u(n-1)$

6. The following are the impulse responses of continuous-time LTI systems. Determine whether each system is causal and/or stable. Justify your answers.

(a) $h(t) = e^{-4t} u(t-2)$ (b) $h(t) = e^{-6t} u(3-t)$ (c) $h(t) = e^{-2t} u(t+50)$

(d) $h(t) = te^{-t} u(t)$