Problem 1

(20 points) Determine the values of P_∞ and E_∞ for each of the following signals:

(a) $x_2(t) = e^{j(2t+\frac{\pi}{4})}$

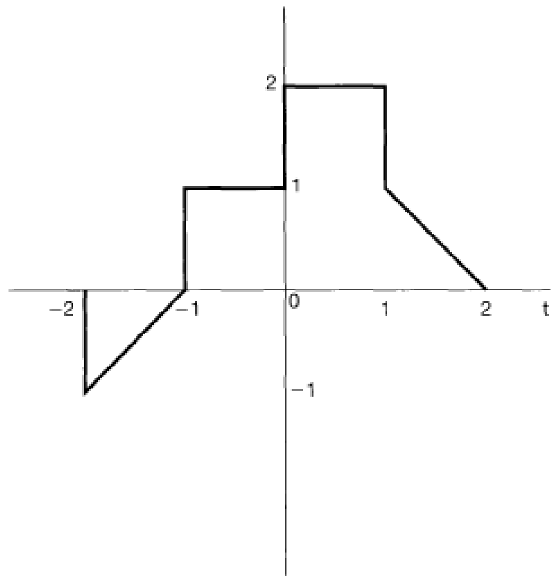
(b) $x_1[n] = \left(\frac{1}{2}\right)^n u[n]$

Problem 2

(20 points) A continuous-time signal $x(t)$ is shown in the following figure. Sketch and label carefully each of the following signals:

(a) $x(2t+1)$

(b) $x(t)\left[\delta\left(t+\frac{3}{2}\right)-\delta\left(t-\frac{3}{2}\right)\right]$



Problem 3

(15 points) Determine whether or not each of the following continuous-time signals is periodic. If the signal is periodic, determine its fundamental period.

(a) $x(t) = 3\cos\left(4t + \frac{\pi}{3}\right)$

(b) $x(t) = \mathrm{E}_v\left\{|\sin(4\pi t)|\, u(t)\right\}$

(c) $x(t) = e^{j(\pi t - 1)}$

Problem 4

(25 points) In this chapter, we introduced a number of general properties of systems. In particular, a system may or may not be

(1) Memoryless

(2) Invertible

(3) Causal

(4) Stable

(5) Time invariant

(6) Linear

Determine which of the properties hold and which do not hold 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)

$$y(t) = [\cos(3t)]x(t)$$

(b)

$$y(t) = \begin{cases} 0, & t < 0 \\ x(t) + x(t-2), & t \geq 0 \end{cases}$$

(c)

$$y(t) = \begin{cases} 0, & x(t) < 0 \\ x(t) + x(t-2), & x(t) \geq 0 \end{cases}$$

Problem 5

(20 points) Let $x[n]$ be a discrete-time signal, and let

$$y_1[n] = x[2n] \quad \text{and} \quad y_2[n] = \begin{cases} x[n/2], & \text{n even} \\ 0, & \text{n odd} \end{cases}$$

The signals $y_1[n]$ and $y_2[n]$ respectively represent in some sense the speeded up and slowed down versions of $x[n]$. However, it should be noted that the discrete-time notions of speeded up and slowed down have subtle differences with respect to their continuous-time counterparts. Consider the following statements:

(1) If $x[n]$ is periodic, then $y_1[n]$ is periodic.

(2) If $y_1[n]$ is periodic, then $x[n]$ is periodic.

(3) If $x[n]$ is periodic, then $y_2[n]$ is periodic.

(4) If $y_2[n]$ is periodic, then $x[n]$ is periodic.

For each of these statements, determine whether it is true, and if so, determine the relationship between the fundamental periods of the two signals considered in the statement. If the statement is not true, produce a counterexample to it.