Problem Set 1 (Due Wednesday 1/27)
Problems A1.1, A1.2, 1.52, 1.53, 1.54

Problem A1.1
Determine whether or not each of the following continuous-time signals is periodic. If the signal is periodic, determine its fundamental period.

(a) \( x(t) = 3 \cos(\sqrt{2}t + \frac{\pi}{4}) \)
(b) \( x(t) = e^{j(2t-1)} \)
(c) \( x(t) = [\cos(4t - \frac{\pi}{3})]^2 \)
(d) \( x(t) = Od\{\cos(4\pi t)u(t)\} \)
(e) \( x(t) = Od\{\sin(4\pi t)u(t)\} \)
(f) \( x(t) = \sum_{n=-\infty}^{\infty} e^{-3(t-n)}u(3t-n) \)
(g) \( x(t) = \cos(4t) + \sin(4\pi t) \).

Problem A1.2
Determine whether or not each of the following discrete-time signals is periodic. If the signal is periodic, determine its fundamental period.

(a) \( x[n] = \sin\left(\frac{2}{3}\pi n \right) - 1 \)
(b) \( x[n] = \cos\left(\frac{\pi}{6} n \right) - \pi \)
(c) \( x[n] = \cos\left(\frac{\pi}{6} n^2 \right) \)
(d) \( x[n] = \cos\left(\frac{\pi}{6} n \right) \cos\left(\frac{3}{5} n \right) \)
(e) \( x[n] = 2\cos\left(\frac{\pi}{6} n \right) + \sin\left(\frac{\pi}{6} n \right) - 4\cos\left(\frac{1}{2} n + \frac{\pi}{6} \right) \)

Problem Set 2 (Due Monday 2/1)
Problems 1.21, 1.22, 1.32, 1.36

Problem Set 3 (Due Monday 2/8)
Problem A1.3

Consider the following properties

1. Memoryless
2. Time-invariant
3. Linear
4. Causal
5. Stable

Determine which of these 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) $y(t) = x(t - 3) + x(3 - t)$
(b) $y(t) = \cos(-3t)x(t)$
(c) $y(t) = \int_{-\infty}^{t} x(\tau)d\tau$
(d) $y(t) = \begin{cases} 0 & t < 0 \\ x(t) + x(2 - t) & t \geq 0 \end{cases}$
(e) $y(t) = \begin{cases} 0 & x(t + 2) < 0 \\ x(t) + x(2 - t) & x(t + 2) \geq 0 \end{cases}$
(f) $y(t) = x(2t)$.
(g) $y(t) = \frac{dx(t-1)}{dt}$

Problem A1.4

Consider the following properties

1. Memoryless
2. Time-invariant
3. Linear
4. Causal
5. Stable

Determine which of these properties hold and which do not hold 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) $y[n] = x[1 - n]$
(b) $y[n] = x[2n - 2] - 2x[n - 8]$
(c) $y[n] = \sin(\pi n)x[n]$
(d) $y[n] = \mathcal{E}v\{x[n + 1]\}$
(e) $y[n] = \begin{cases} x[n-1] & n \geq 1 \\ 0 & n = 0 \\ x[n] & n \leq -1 \end{cases}$

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

(g) $y[n] = x[-4n + 1]$
Problem A2.1

Compute the convolution $y[n] = x[n] \ast h[n]$ of the following pair of signals

(a) $x[n] = \alpha^n u[n - 1], h[n] = \beta^n u[n], \alpha \neq \beta$.

(b) $x[n] = \alpha^n u[n - 1], h[n] = \alpha^n u[n]$

(c) $x[n] = \left(\frac{1}{2}\right)^n u[n - 3], h[n] = (-3)^n u[4 - n]$.

(d) $x[n] = \begin{cases} 1 & 0 \leq n \leq 5 \\ 0 & \text{otherwise} \end{cases}; h[n] = \begin{cases} 1 & 1 \leq n \leq 5 \\ 1 & 8 \leq n \leq 13 \\ 0 & \text{otherwise} \end{cases}$

Problem Set 5 (Due Monday 2/22)

Problems 2.22, A2.3, A2.4, A2.5

Problem A2.3

The following are the impulse responses of discrete-time LTI systems. Determine whether each system is causal and/or stable. Justify your answers. The justification for stability needs to in terms of the summation condition.

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

(b) $h[n] = (-1.8)^n u[n - 2]$

(c) $h[n] = (2)^n u[-n + 1]$

(d) $h[n] = \left(\frac{4}{9}\right)^n u[-1 - n]$

(e) $h[n] = \left(-\frac{1}{2}\right)^n u[n] + 1.01^n u[n + 1]$

(f) $h[n] = \left(-\frac{1}{2}\right)^n u[n] + 0.99^n u[1 - n]$

(g) $h[n] = n^2 \left(\frac{1}{2}\right)^n u[n - 3]$

Problem A2.4

The following are the impulse responses of continuous-time LTI systems. Determine whether each system is causal and/or stable. Justify your answers. The justification for stability needs to in terms of the integration condition.

(a) $h(t) = e^{-4t}u(-t - 2)$

(b) $h(t) = e^{-2t}u(t - 2)$

(c) $h(t) = e^{-1.1t}u(t + 100)$

(d) $h(t) = e^{-4t}u(t - 2)$

(e) $h(t) = e^{-|t|}$

(f) $h(t) = t^2 e^{-t/2}u(t)$

(g) $h(t) = (2e^{-t/2} - e^{(10-t)/10}) u(t + 2)$

(h) $h(t) = \frac{t}{(t+1)^{10}}$
Problem A2.5

1. The impulse response of an LTI system is given by

\[ h(t) = \cos(t)u(t) \]

If the input is \( x(t) = u(t) \), calculate the output.

2. The impulse response of an LTI system is given by

\[ h[n] = (-2)^{|n|} \]

If the input is \( x[n] = u[n] - u[n - 2] \), calculate the output.

Problem Set 6 (Due Monday 3/7)

Problems 2.30, 3.22, 3.23, 3.24, 3.26, A3.5

Problem A3.5

The following plot shows a signal \( x(t) \) with period \( T = 4 \).

1. Find the Fourier coefficients of \( x(t) \).

2. Sketch the signal with period \( T = 4 \) having Fourier coefficients

\[ a_k = \begin{cases} 0 & k = 0 \\ -3 \frac{\sin(k \frac{\pi}{2})}{k\pi} & k \neq 0 \end{cases} \]

3. Sketch the signal with period \( T = 4 \) having Fourier coefficients

\[ a_k = \begin{cases} -\frac{1}{2} & k = 0 \\ -6e^{j \frac{\pi}{4}} \frac{\sin(k \frac{\pi}{2})}{k\pi} & k \neq 0 \end{cases} \]

4. Sketch the signal with period \( T = 4 \) having Fourier coefficients

\[ a_k = \begin{cases} -\frac{1}{2} & k = 0 \\ 3j \frac{\sin(k \frac{\pi}{2})}{k^2\pi} & k \neq 0 \end{cases} \]