Problems: Time-Domain System Descriptions Review

AllSignalProcessing.com

1. Which of the following systems with input $x(t)$ and output $y(t)$ are stable? Select all that apply.

a)

$$\frac{d}{dt}y(t) - 0.5y(t) = 2x(t) + \frac{d}{dt}x(t)$$

b)

$$y(t) = \int_{-\infty}^{\infty} x(t-\tau)h(\tau)d\tau, \quad h(\tau) = \cos(\pi\tau)u(\tau+1)$$

c)

$$y(t) = \log(x(t+1))$$

d)

$$\frac{d}{dt}y(t) + 3y(t) = \frac{d}{dt}x(t)$$

e) none are stable

2. Which of the following systems with input $x(t)$ and output $y(t)$ are causal? Select all that apply.

a)
$$\frac{d}{dt}y(t) - 0.5y(t) = 2x(t) + \frac{d}{dt}x(t)$$

b)
$$y(t) = \int_{-\infty}^{\infty} x(t-\tau)h(\tau)d\tau, \quad h(\tau) = \cos(\pi\tau)u(\tau+1)$$

c)
$$y(t) = \log(x(t+1))$$

d)
$$\frac{d}{dt}y(t) + 3y(t) = \frac{d}{dt}x(t)$$

e) none are causal

3. Which of the following systems with input $x(t)$ and output $y(t)$ are time-invariant? Select all that apply.

a)

$$y(t) = \int_{-\infty}^{\infty} x(t-\tau)h(\tau)d\tau, \quad h(\tau) = e^{-\tau}\sin(\pi\tau)u(\tau-1)$$

b)

$$\frac{d}{dt}y(t) - 0.5y(t) = 2tx(t) + \frac{d}{dt}x(t)$$

c)

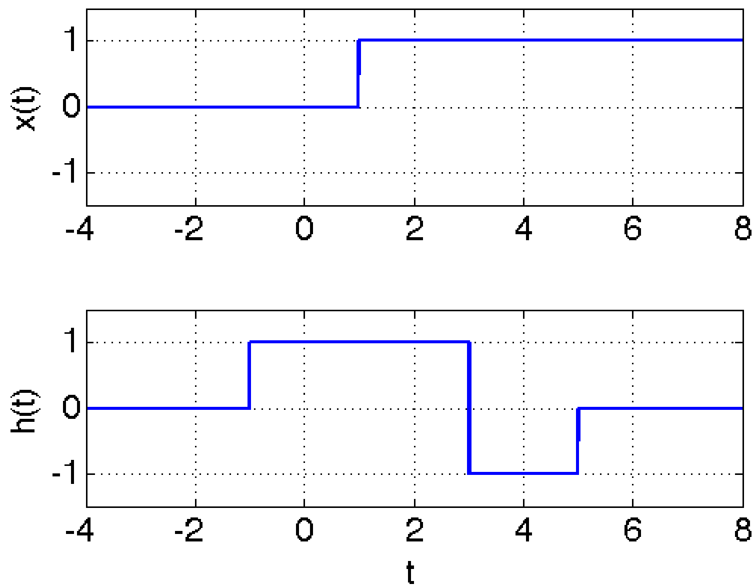
$$y(t) = (t+1)^2\cos(x(t+1))$$

d)

$$\frac{d}{dt}y(t) + 3y(t) = \frac{d}{dt}x(t)$$

e) none are time invariant

4. Consider a system with impulse response $h(t) = u(t+1) - 2u(t-3) + u(t-5)$ and input signal $x(t) = u(t-1)$, as shown below. Note the the signals continue outside the time



ranges shown by holding the values at the boundary of the graphs. Answer the questions on the following pages about the output $y(t)$ of this system.

a) $y(t)$ is constant for $t <$ __________ and on this range $y(t) =$ __________.

b) As t increases beyond the answer to the previous question, $y(t)$ is (increasing, decreasing, constant) until $t =$ __________.

c) As t increases beyond the answer to the previous question, $y(t)$ is (increasing, decreasing, constant) until $t =$ __________.

d) Find $y(t)$.

5. A system with input $x[n]$ and output $y[n]$ is described by the difference equation

$$y[n] - \frac{1}{4}y[n-1] + ay[n-2] = x[n] + bx[n-1]$$

If the input is $x[n] = u[n]$ the output of the system is found to be $y[n] = 1 + \left(\frac{1}{2}\right)^n + 2\left(-\frac{1}{4}\right)^n$ for $n \geq 0$.

a) Enter the value $a =$ ___________.

b) Enter the value $b =$ ___________.

c) Find the initial conditions $y[-1] =$ ________ and $y[-2] =$ ________.

d) Suppose the input is now $x[n] = 10(1/8)^n u[n]$. The steady-state component of the output is $y_s[n] = Ap^n$ where $A =$ ________ and $p =$ ________.