EE1101 Signals and Systems JAN—MAY 2018
Tutorial 4
February 26, 2018

1. The impulse response to an LTI system is given as,

$$h(t) = \begin{cases} 2e^{-t}, & 0 \leq t < 3 \\ 0, & t \geq 3. \end{cases}$$

Find the response to an input,

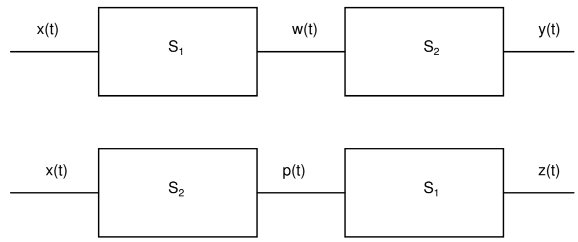
$$i(t) = \begin{cases} 4u(t), & 0 \leq t < 2 \\ 0, & t \geq 2. \end{cases}$$

2. Given that $f(t) \star g(t) = y(t)$, where $\star$ denotes convolution,
   (a) Find $f(t - T_1) \star g(t - T_2)$, for some finite-valued real numbers T_1 and T_2.
   (b) Use the result of (a) and the fact that $u(t) \star u(t) = r(t)$, to find $(u(t+1) - u(t-2)) \star (u(t-3) - u(t-4))$. Verify the result graphically.

3. Given $y(t) = f(t) \star g(t)$, derive a general formula to compute $f(ct) \star g(ct), c \neq 0$. Hence, if $f(t) = u(t+1) - u(t-2)$ and $g(t) = r(t)(u(t) - u(t-1))$, find $f(2t) \star g(2t)$.

4. Given below are the impulse response of some systems. Determine whether the systems are (a) Stable (b) Causal and (c) Instantaneous.
   (a) $h(t) = e^{-(t+2)}u(t)$.
   (b) $h(t) = e^{-|t|}$.
   (c) $h(t) = \delta(t) + \delta(t-3)$.

5. Let $x(t) = e^{-2t}u(t)$. The system S_1 is described by $y(t) = x(2t)$ and the system S_2 has an impulse response $h(t) = e^{-t}u(t)$. Find the output for the following two cascaded connections. Are the outputs expected to be the same in both cases?



6. The impulse response of a LTI system is $h(t) = e^{-2t}u(t)$. Find the response to the following inputs:
   (a) $x_1(t) = 5u(t)$.
   (b) $x_2(t) = \cos(4\pi t)$.

7. Determine whether each of the following statements concerning LTI systems is true or false. Justify your answers.
   (a) If $h(t)$ is the impulse response of an LTI system, and h(t) is periodic and nonzero, the system is unstable.
   (b) The inverse of a causal LTI system is always causal.
   (c) If $|h[n]| < K$ for each n, where K is a given number, then the LTI system with $h[n]$ as its impulse response is stable.
   (d) If a discrete-time LTI system has a impulse response $h[n]$ of finite duration, the system is stable.
   (e) If an LTI system is causal, it is stable.
   (f) The cascade of a noncausal LTI system with a causal one is necessarily noncausal.
   (g) A continuous-time LTI system is stable if and only if its step response $s(t)$ is absoultely integrable, that is,

$$\int_{-\infty}^{+\infty} |s(t)| dt < \infty$$

(h) A discrete-time LTI system is causal if and only if its step response $s[n]$ is zero for $n < 0$.

8. Consider two systems A and B. It is given that system A is LTI and system B is an inverse of system A.

   (a) Prove that system B is linear.

   (b) Prove that system B is time-invariant.

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