ECE102, Fall 2020 **Discussion 3**

Signals & Systems Prof. J. Kao

University of California, Los Angeles; Department of ECE TAs: A. Ghosh, T. Monsoor, G. Zhao

1. **System properties**

   (a) Consider the following system with input $x(t)$ and output $y(t)$,

   $$y(t) = x(t)u(t)$$

   i. Sketch $y(t)$ for $x(t) = e^{-t}$

   ii. Is the system linear?

   iii. Is the sytem time-invariant?

   iv. Is the system causal?

   v. Is the system memoryless?

   (b) Consider the continuous-time system defined by the following input-output relationship

   $$y(t) = \sum_{m=-1}^{m=2} m x(t-m)$$

   i. Sketch $y(t)$ for the input $x(t) = u(t)$

   ii. Is the system memoryless?

   iii. Is the system causal?

   iv. Is the system BIBO stable?

2. **LTI systems**

   A particularly interesting communication channel can be modeled as a LTI system. When the transmitted signal $x(t)$ is a pulse, the received signal $r(t)$ is as shown:

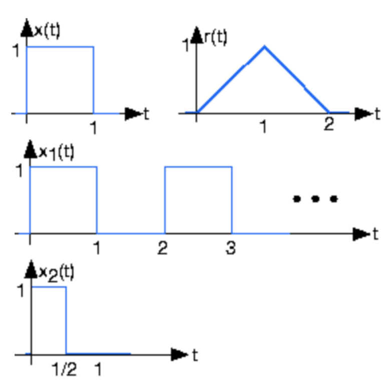


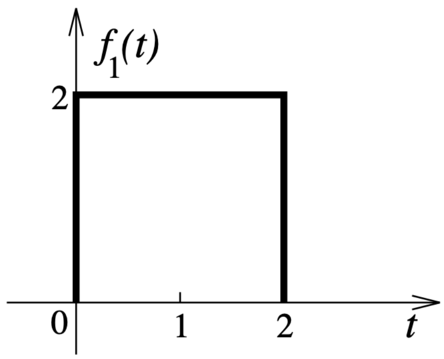
Figure 1: Communication channel and pulse sequence

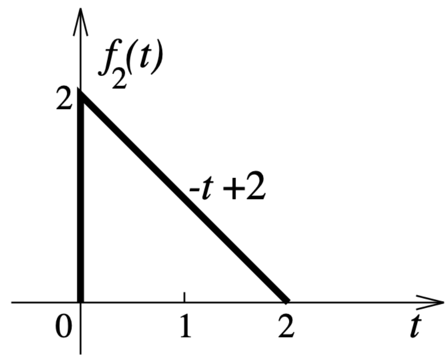
(a) What will be the received signal when the transmitter sends the pulse sequence $x_1(t)$?

(b) What will be the received signal when the transmitter sends the pulse sequence $x_2(t)$ that has half the duration as the original?

3. **Convolution**

(a) Consider the signals, $f_1(t)$ and $f_2(t)$, given in figure below





Use the flip-and-drag technique to find an analytic expression for $f_1(t) * f_2(t)$.

(b) Let $h_1(t)$, $h_2(t)$, $h_3(t)$, and $h_4(t)$ be impulse responses of LTI systems. Construct a system with impulse response $h(t)$ using $h_1(t)$, $h_2(t)$, $h_3(t)$, and $h_4(t)$ as subsystems. Draw the interconnection of systems required to obtain:

i. $h(t) = h_1(t) + \{h_2(t) + h_3(t)\} * h_4(t)$

ii. $h(t) = h_1(t) * h_2(t) + h_3(t) * h_4(t)$

iii. $h(t) = h_1(t) * \{h_2(t) + h_3(t) + h_4(t)\}$