EE3210 Signals & Systems

Due on Midnight, Feb 28, 2020

Homework #1

1. Total mark is 20 points (= 4 points per problem $\times$ 5 problems)
2. Solution will be posted on March 3rd on Canvas website
3. Submission due by Feb 28, 2020, midnight. We will accept late submission until March 2, 2020
4. Late submission penalty; -5 points per day
    - Full mark: 20 points (Feb 28), 15 points (Feb 29), 10 points (March 01), 5 points (March 02), and 0 points for any late submission after March 3rd.
5. Online submission through Canvas
    - Scan or taking a photo of your anwser sheet, then upload to Canvas

Problem 1

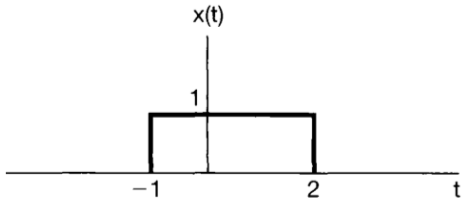
Let's consider an LTI system with intput and output relatex through the equation

$$y(t) = \int_{-\infty}^{t} e^{-(t-\tau)} x\left(\tau - 2\right) d\tau \tag{1}$$

a) Find the impulse response $h(t)$ for the given system (1).

b) Is this system causal or not?

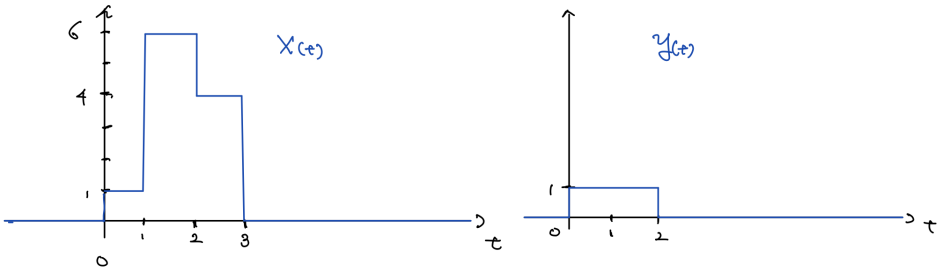
c) Determine the output of the system when the input $x(t)$ is as shown below.



Problem 2

Evaluate the following convolution where $x(t)$ and $y(t)$ are plotted below

$$z(t) = x(t) * y(t)$$



Hint. Express the signals as a linear combination of time-delayed unit step function and apply the lemma

$$u\,(t+a) * u\,(t+b) = (t+a+b)\,u\,(t+a+b)$$

Problem 3

Derive the following convolution

$$x(t) * x(t) * x(t) \tag{2}$$

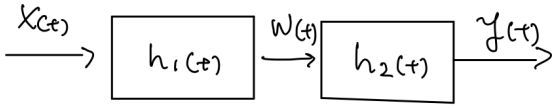
where $x(t) = u(t+1) - u(t-1)$ is a rectangular pulse signal.

Hint. Use the following lemma

$$(t+a)\,u(t+a) * u(t+b) = \frac{1}{2}(t+a+b)^2\,u(t+a+b)$$

Problem 4

Consider an LTI system with two sub-components connected in a cascaded manner as shown below.



a) Find the overall impulse response $h(t)$ when the impulse response of the each components are given by

$$h_1(t) = \delta(t) - 2e^{-2t}u(t), \quad h_2(t) = e^{t}u(t)$$

b) Is this system causal or not? Also, is it a stable system or not?

Problem 5

Consider the following systems and answer whether they are linear, causal, or time-invariant.

	Linear	Causal	Time-invariance
a) $y(t) = 2x(t) + 3$			
b) $y(t) = 2x^2(t) + 3x(t)$			
c) $y(t) = Atx(t)$			
d) $y(t) = x(t)x(t-2)$			
e) $y(t) = \exp(x(t))$			
f) $y(t) = \cos(3t)x(t)$			