# Home Assignment

Signals & Systems: IIIT Sri City

18 April 2019

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**Instructions**

1. Maximum Grade: 40
2. Please complete the home assignment before 18, April, 2019.
3. Please write all the solution by hand
4. Please provide the solutions in the correct order
5. Finally scan the handwritten notes and upload it to the classroom

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# 1 Fundamentals

## 1.1 Signal Power

1. Given the signal

$$x(t) = Acos(\omega t + \phi)$$

Determine the average power of $x(t)$.

2. A rectangular pulse $x(t)$ is defined by

$$\begin{aligned} x(t) &= A \quad 0 \leq t \leq T \\ &\quad 0, \quad Otherwise \end{aligned}$$

The pulse $x(t)$ is applied to an integrator defined by

$$y(t) = \int_0^t x(\tau) d\tau$$

Determine the average power of $y(t)$

## 1.2 Signal Transformations

Given the signals $x(t)$ and $y(t)$ in the figure 1, plot the following

1. x(t) y(t-4)
2. x(t+1) y(t-4)
3. x(4-t) y(t-1)

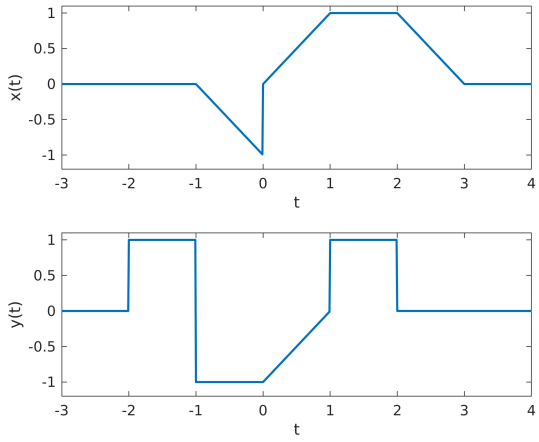


Figure 1: Composite signals

# 2 Linear Systems

## 2.1 Properties of LTI

Determine whether the following systems are (a) causal, (b) stable, (c) linear and (d) time invariant

1. $$y(t) = \frac{d}{dt}x(t)$$

2. $$y[n] = x[2 - n]$$

## 2.2 Linear Convolution

Determine the output of the discrete linear systems with the following input and impulse response combinations

1. $$x[n] = cos\left[\frac{\pi}{2}n\right]$$

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

2. $$x[n] = \begin{array}{ll} 1 & -5 \leq n \leq 1 \\ 0 & \text{otherwise} \end{array}$$

$$h[n] = \begin{array}{ll} 1 & 0 \leq n \leq 3 \\ 2 & 4 \leq n \leq 8 \\ 0 & \text{otherwise} \end{array}$$

# 3 Fourier Representation of Signals

## 3.1 Fourier Series

For the given periodic signals, compute the Fourier coefficients from the definitions of the signal in the fundamental period:

1.
$$x(t) = 1 - \frac{|t|}{3} \quad |t| < 1 \quad : T = 3$$

2.
$$x[n] = cos\left[\frac{\pi}{5}n\right] \quad |n| \leq 2 \quad : N = 5$$

## 3.2 Fourier Transform

For the given aperiodic signals, compute the Fourier transform

1.
$$\begin{aligned} x(t) &= 2 \quad |t| < 1 \\ &\quad 0 \quad \text{otherwise} \end{aligned}$$

2.
$$\begin{aligned} x(t) &= exp\left(-\frac{|t|}{2}\right) \quad |t| < 1 \\ &\quad 0 \quad \text{otherwise} \end{aligned}$$

## 3.3 Inverse Transform

For the given spectra, determine the corresponding time domain signals

1.
$$X(\omega) = sinc^2(\omega)$$

2.
$$X(\omega) = \frac{1}{1 + j\omega RC}$$

Note that $R$ and $C$ are resistance and capacitance in the circuit and can be assumed to be known.

# 4 Discrete Fourier Transforms

## 4.1 DFT

Determine the N-point DFT of the Blackman window given below

$$w[n] = 0.42 - 0.5cos\left(\frac{2\pi n}{N-1}\right) + 0.08cos\left(\frac{4\pi n}{N-1}\right)$$

## 4.2 Circular Convolution

Use the four point DFT and IDFT to determine the sequence

$$x_3[n] = x_1[n] \circledast x_2[n]$$

Given

$$x_1[n] = \{\underset{\uparrow}{1}, 2, 3, 1\}$$
$$x_2[n] = \{\underset{\uparrow}{4}, 3, 2, 2\}$$