

Spring 2019 - Problem Set 3

ECE 301: Signals and Systems

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Due Date : March 1, 2019

Instructions

1. Please write clearly and legibly.
2. Your solutions must include detailed steps and/or explanations. Do not simply state the answer.
3. Write your full name (first,last), PUID on your homework submission.
4. All problems carry equal weight.

Problem 1

Compute the Fourier Series Coefficients of the following signals.

a $x_1(t) = e^{j\frac{3\pi}{2}t}$

b $x_2(t) = \sin(3t) + j \cos(5t)$

c $x_3(t) = \left(\cos\left(\frac{2\pi n}{5}\right)\right) \left(1 + 2 \sin\left(\frac{2\pi n}{5}\right)\right)$

d $x_4(t)$ in Figure 1 (Amplitude is 1).

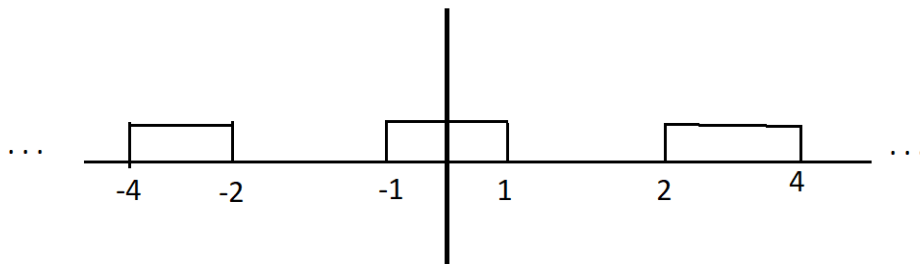


Figure 1: $x_4(t)$

Problem 2

For the following impulse response signals, comment if the corresponding LTI systems are: (1) Invertible (2) Stable (3) Causal (4) Linear. Justify your answer.

a $h[n] = \delta[n - 1]$

b $h(t) = u(t)$

c $h[n] = \sum_{k=n+1}^{n+5} \delta[k]$

d $h[n] = \sum_{k=-\infty}^{n-4} \delta[k]$

Problem 3

Derive alternative simplified representations of the Fourier Series representation for Continuous-Time (1) real, periodic signals (2) purely imaginary periodic signals.

Problem 4

- What is Euler's observation on the movement of strings? What was the criticism of his observation?
- Describe Fourier's discovery on the application of trigonometric signals.
- If a periodic signal has finite energy, what does that imply on the convergence of its Fourier Series representation?
- State Dirichlet conditions. Give examples of periodic signals violating each condition. If a periodic signal satisfies all three conditions, what does that imply?

Problem 5

- For $x[n]$ in Figure 2, find the Fourier Series representation.
- Consider the following signal with period $T = 1$

$$x(t) = \begin{cases} t, & 0 \leq t \leq 0.5 \\ 1 - t, & 0.5 \leq t \leq 1 \end{cases}$$

- Find the Fourier Series representation of $\frac{dx(t)}{dt}$
- Find the DC component of $\frac{dx(t)}{dt}$
- Find the DC component of $x(t)$

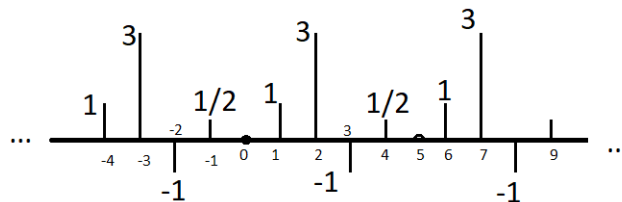


Figure 2: Caption