

# DSA-Assignment-2

Deadline: 4th February 2025

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1. Solve all the question and submit a handwritten document
  2. Plagiarism will be penalised
  3. Submit a pdf of the form <roll\_no>\_dsa2.pdf
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## 1 Signals – 36 Marks [Signal Properties]

1. Find the odd and even parts of the following discrete signals.
  - (a)  $x[n] = \sqrt{2} \cos((an + 1/4)\pi)$  [1 M]
  - (b)  $x[n] = e^{jan\pi} + e^{jn\pi/b}$  [1 M]
2. Indicate if the following signals are periodic signals. If periodic, find the fundamental period.
  - (a)  $x[n] = \sin(4\pi n + 3)$  [4 M]
  - (b)  $x[n] = \cos(\pi n^2/3)$  [4 M]
  - (c)  $x[n] = \sum_{k=-\infty}^{\infty} (-1)^k \delta(n - k)$  [2 M]
  - (d)  $x[n] = \sin^2(3n + \pi)$  [2 M]
  - (e)  $x[n] = e^{j\pi n/8}$  [4 M]
  - (f)  $x[n] = \cos(\pi n/10) \cos(\pi n/30)$  [4 M]
3. Determine whether the following signals are energy or power signals or neither.
  - (a)  $x[n] = a^n u(n), a \in \mathbb{R}$  [6 M]
  - (b)  $x[n] = e^n \delta(n - 6)$  [2 M]
  - (c)  $x[n] = \cos(n\pi/2)$  [2 M]
  - (d)  $x[n] = \begin{cases} 0 & n < 0 \\ n & n \geq 0 \end{cases}$  [2 M]
  - (e)  $x[n] = \begin{cases} 5^n & n < 0 \\ (\frac{1}{2})^n & n \geq 0 \end{cases}$  [2 M]

## 2 Systems – 32 M [Time Invariance, Linearity, Causality]

1. Determine whether or not the following systems are time invariant.

(a)  $y[n] = x[n - 1] + x[n + 1]$  [2 M]

(b)  $y[n] = \frac{1}{x[n]}$  [2 M]

(c)  $y[n] = nx[n]$  [2 M]

(d)  $y(t) = t^2x(t - 1)$  [2 M]

(e) Consider a system  $S$  with input  $x[n]$  and output  $y[n]$  related by  $y[n] = x[n](g[n] + g[n - 1])$ .

i. If  $g[n] = 1$  for all  $n$ , show that  $S$  is time invariant.

ii. If  $g[n] = n$ , show that  $S$  is not time invariant.

iii. If  $g[n] = 1 + (-1)^n$ , show that  $S$  is time invariant.

[4 M]

2. Determine whether or not the following systems are linear.

(a)  $y(t) = x(\sin t)$  [2 M]

(b)  $y(t) = \frac{d(x(t))}{dt}$  [2 M]

(c)  $y[n] = \sum_{m=0}^M ax[n - m] + \sum_{m=1}^N bx[n - m]$  [2 M]

(d)  $y[n] = ax[n] + \frac{b}{x[n-1]}$  [2 M]

(e)  $y(t) = \begin{cases} 0 & \text{if } t < 0 \\ x(t) + x(t - 2) & \text{if } t \geq 0 \end{cases}$  [2 M]

3. Determine whether or not the following systems are causal.

(a)  $y(t) = x(t - 2) + x(2 - t)$  [2 M]

(b)  $y[n] = \sum_{k=0}^{\infty} x[n + k]$  [2 M]

(c)  $y[n] = \sum_{k=0}^{\infty} x[n - k]$  [2 M]

(d)  $y(t) = x(t) \cdot \cos(3t)$  [2 M]

(e)  $y(t) = \int_{-\infty}^{2t} x(k)dk$  [2 M]

## 3 Convolution – 22 M [Linear and Circular]

1. Compute the circular convolution of  $x_1[n] = \{4, 1, 4, 1\}$  &  $x_2[n] = \{1, 2, 3, 4\}$  using DFT & IDFT. [12 M]

2. Find the linear and circular convolution of the sequences  $x[n] = \{1, 2, 3, 4, 5\}$  &  $h[n] = \{-1, 1, 0, 1\}$ . [10 M]