

DSA-Assignment-2

Deadline: 5th April 2024

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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

1. Indicate if the following signals are periodic signals. If periodic, find the fundamental period

(2 mark) (a) $x[n] = \sin^2(3n + \pi)$

(4 mark) (b) $x[n] = e^{j\pi n/8}$

(4 mark) (c) $x[n] = \cos(\pi n/10) \cos(\pi n/30)$

(4 mark) (d) $x[n] = \sin(4\pi n + 3)$

(4 mark) (e) $x[n] = \cos(\pi n^2/3)$

(2 mark) (f) $x[n] = \sum_{k=-\infty}^{\infty} (-1)^k \delta(n - k)$

2. Find the odd and even parts of the following discrete signals

(1 mark) (a) $x[n] = \sqrt{2} \cos((an + 1/4)\pi)$

(1 mark) (b) $x[n] = e^{jan\pi} + e^{jn\pi/b}$

3. Determine whether the following signals are energy or power signals or neither

(2 mark) (a) $x[n] = \begin{cases} 0 & n < 0 \\ n & n \geq 0 \end{cases}$

(2 mark) (b) $x[n] = \cos(n\pi/2)$

(2 mark) (c) $x[n] = \begin{cases} 3^n & n < 0 \\ (\frac{1}{2})^n & n \geq 0 \end{cases}$

(6 mark) (d) $x[n] = a^n u(n), a \in R$

(2 mark) (e) $x[n] = e^n \delta(n - 4)$

2 Systems - 32 marks

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

- (a) **(2 mark)** $y(t) = t^2 x(t - 1)$
- (b) **(2 mark)** $y[n] = x[n - 1] + x[n + 1]$
- (c) **(2 mark)** $y[n] = \frac{1}{x[n]}$
- (d) **(6 mark)** Consider a system S with input $x[n]$ and output $y[n]$ related by $y[n] = x[n](g[n] + g[n - 1])$.
 - (a) If $g[n] = 1$ for all n , show that S is time invariant.
 - (b) If $g[n] = n$, show that S is not time invariant.
 - (c) If $g[n] = 1 + (-1)^n$, show that S is time invariant.

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

- (a) **(2 mark)** $y(t) = x(\sin t)$
- (b) **(2 mark)** $y(t) = \begin{cases} 0 & \text{if } t < 0 \\ x(t) + x(t - 2) & \text{if } t \geq 0 \end{cases}$
- (c) **(2 mark)** $y(t) = \frac{d(x(t))}{dt}$
- (d) **(2 mark)** $y[n] = \sum_{m=0}^M ax[n - m] + \sum_{m=1}^N bx[n - m]$
- (e) **(2 mark)** $y[n] = ax[n] + \frac{b}{x[n-1]}$

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

- (a) **(2 mark)** $y(t) = x(t - 2) + x(2 - t)$
- (b) **(2 mark)** $y(t) = x(t) \cdot \cos(3t)$
- (c) **(2 mark)** $y(t) = \int_{-\infty}^{2t} x(k)dk$
- (d) **(2 mark)** $y[n] = \sum_{k=0}^{\infty} x[n + k]$
- (e) **(2 mark)** $y[n] = \sum_{k=0}^{\infty} x[n - k]$

3 Convolution - 22 marks

- 1. **(10 mark)** Find the linear and circular convolution of the sequences $x[n] = \{-1, 1, 0, 1\}$ and $h[n] = \{1, 2, 3, 4, 5\}$.
- 2. **(12 mark)** Compute the circular convolution of $x_1[n] = \{2, 1, 2, 1\}$ and $x_2[n] = \{1, 2, 3, 4\}$ using DFT and IDFT.