

Linear System Properties Analysis



(a) $T(x[n]) = g[n]x[n]$ with $g[n]$ given

(b) $T(x[n]) = \sum_{k=n_0}^n x[k]$

(c) $T(x[n]) = \sum_{k=n-n_0}^{n+n_0} x[k]$

(d) $T(x[n]) = x[n - n_0]$

(e) $T(x[n]) = e^{x[n]}$

(f) $T(x[n]) = ax[n] + b$

(g) $T(x[n]) = x[-n]$

(h) $T(x[n]) = x[n] + 3u[n + 1]$

For each of the following systems, determine whether the system is (1) stable, (2) causal, (3) linear, (4) time invariant, and (5) memoryless:



Let's analyze each of the given systems for the properties specified: stability, causality, linearity, time invariance, and memorylessness.

(a) $T(x[n]) = g[n]x[n]$ with $g[n]$ given

1. Stability:

- The system is stable if $g[n]$ is bounded. If $g[n]$ is bounded, then $T(x[n])$ will be bounded whenever $x[n]$ is bounded.
- **Stability** depends on $g[n]$.

2. Causality:

- The system is causal if $g[n]$ depends only on n and not on future values of $x[n]$.
- **Causal** if $g[n]$ is not anticipative.

3. Linearity:

- The system is linear because $T(ax_1[n] + bx_2[n]) = g[n](ax_1[n] + bx_2[n]) = ag[n]x_1[n] + bg[n]x_2[n]$.

- **Linear.**

4. Time Invariance:

- The system is time-invariant if $g[n]$ is independent of n . If $g[n]$ changes with n , it is not time-invariant.
- **Time Invariance** depends on $g[n]$.

5. Memorylessness:

- The system is memoryless because $T(x[n])$ depends only on $x[n]$ and not on past or future values.
- **Memoryless.**

(b) $T(x[n]) = \sum_{k=n_0}^n x[k]$

1. Stability:

- The system is not necessarily stable because the sum of $x[k]$ can grow unbounded.
- **Not stable.**

2. Causality:

- The system is causal because it depends only on the current and past values of $x[n]$.
- **Causal.**

3. Linearity:

- The system is linear because the summation operator is linear.
- **Linear.**

4. Time Invariance:

- The system is time-invariant because shifting $x[n]$ results in the same shift in $T(x[n])$.
- **Time Invariant.**

5. Memorylessness:

- The system has memory because the output depends on past values of $x[n]$.
- **Not memoryless.**

(c) $T(x[n]) = \sum_{k=n-n_0}^{n+n_0} x[k]$

1. Stability:

- The system is not necessarily stable because the sum of $x[k]$ can grow unbounded.
- **Not stable.**

2. Causality:

- The system is not causal because it depends on future values of $x[n]$ (values from n to $n + n_0$).

- **Not causal.**

3. Linearity:

- The system is linear because the summation operator is linear.
- **Linear.**

4. Time Invariance:

- The system is time-invariant because shifting $x[n]$ results in the same shift in $T(x[n])$.
- **Time Invariant.**

5. Memorylessness:

- The system has memory because the output depends on past and future values of $x[n]$.
- **Not memoryless.**

(d) $T(x[n]) = x[n - n_0]$

1. Stability:

- The system is stable if $x[n]$ is stable because it only shifts $x[n]$.
- **Stable.**

2. Causality:

- The system is causal because it depends only on the current and past values of $x[n]$.
- **Causal.**

3. Linearity:

- The system is linear because a shift is a linear operation.
- **Linear.**

4. Time Invariance:

- The system is time-invariant because shifting $x[n]$ results in the same shift in $T(x[n])$.
- **Time Invariant.**

5. Memorylessness:

- The system has memory because the output depends on past values of $x[n]$.
- **Not memoryless.**

(e) $T(x[n]) = e^{x[n]}$

1. Stability:

- The system is not stable because $e^{x[n]}$ can grow unbounded for large $x[n]$.
- **Not stable.**

2. Causality:

- The system is causal because it depends only on the current value of $x[n]$.
- **Causal.**

3. Linearity:

- The system is not linear because $e^{ax[n]+bx[n]} \not\equiv ae^{x[n]} + be^{x[n]}$.
- **Not linear.**

4. Time Invariance:

- The system is time-invariant because shifting $x[n]$ results in the same shift in $T(x[n])$.
- **Time Invariant.**

5. Memorylessness:

- The system is memoryless because $T(x[n])$ depends only on $x[n]$.
- **Memoryless.**

(f) $T(x[n]) = ax[n] + b$

1. Stability:

- The system is stable because $ax[n] + b$ is bounded if $x[n]$ is bounded.
- **Stable.**

2. Causality:

- The system is causal because it depends only on the current value of $x[n]$.
- **Causal.**

3. Linearity:

- The system is not linear because of the constant b .
- **Not linear.**

4. Time Invariance:

- The system is time-invariant because shifting $x[n]$ results in the same shift in $T(x[n])$.
- **Time Invariant.**

5. Memorylessness:

- The system is memoryless because $T(x[n])$ depends only on $x[n]$.
- **Memoryless.**

(g) $T(x[n]) = x[-n]$

1. Stability:

- The system is stable if $x[n]$ is stable because it only reverses $x[n]$.
- **Stable.**

2. Causality:

- The system is not causal because it depends on future values of $x[n]$.
- **Not causal.**

3. Linearity:

- The system is linear because reversal is a linear operation.
- **Linear.**

4. Time Invariance:

- The system is not time-invariant because shifting $x[n]$ does not result in a simple shift in $T(x[n])$.
- **Not time-invariant.**

5. Memorylessness:

- The system has memory because the output depends on values of $x[n]$ at different times.
- **Not memoryless.**

(h) $T(x[n]) = x[n] + 3u[n + 1]$

1. Stability:

- The system is not stable because $3u[n + 1]$ is not bounded.
- **Not stable.**

2. Causality:

- The system is not causal because $3u[n + 1]$ depends on future values of $u[n]$.
- **Not causal.**

3. Linearity:

- The system is not linear because $3u[n + 1]$ is not related linearly to $x[n]$.
- **Not linear.**

4. Time Invariance:

- The system is not time-invariant because the term $3u[n + 1]$ introduces a fixed shift.
- **Not time-invariant.**

5. Memorylessness:

- The system has memory because $3u[n + 1]$ depends on a future value.
- **Not memoryless.**

Here's a summary of the properties:

System	Stable	Causal	Linear	Time Invariant	Memoryless
(a)	Depends on $g[n]$	Depends on $g[n]$	Yes	Depends on $g[n]$	Yes
(b)	No	Yes	Yes	Yes	No
(c)	No	No	Yes	Yes	No
(d)	Yes	Yes	Yes	Yes	No
(e)	No	Yes	No	Yes	Yes
(f)	Yes	Yes	No	Yes	Yes
(g)	Yes	No	Yes	No	No
(h)	No	No	No	No	No

If you have any more questions or need further explanation, feel free to ask!



Prove only the stability of each signal in mathematical terms



Sure, let's mathematically analyze the stability of each system. Stability for a system T means that for any bounded input $x[n]$, the output $T(x[n])$ is also bounded. Mathematically, if $\|x[n]\|$ is bounded, i.e., there exists some constant $M < \infty$ such that $|x[n]| \leq M$ for all n , then $\|T(x[n])\|$ must also be bounded.

(a) $T(x[n]) = g[n]x[n]$ with $g[n]$ given

- To check the stability:

$$|T(x[n])| = |g[n]x[n]|$$

If $x[n]$ is bounded, i.e., $|x[n]| \leq M$, and if $g[n]$ is bounded, i.e., $|g[n]| \leq G$, then:

$$|T(x[n])| = |g[n]x[n]| \leq GM$$

Hence, $T(x[n])$ is bounded if $g[n]$ is bounded. Thus, **stability depends on $g[n]$** .

(b) $T(x[n]) = \sum_{k=n_0}^n x[k]$

- To check the stability:

$$|T(x[n])| = \left| \sum_{k=n_0}^n x[k] \right|$$

If $x[n]$ is bounded, i.e., $|x[n]| \leq M$, then:

$$\left| \sum_{k=n_0}^n x[k] \right| \leq \sum_{k=n_0}^n |x[k]| \leq (n - n_0 + 1)M$$

As $n \rightarrow \infty$, $(n - n_0 + 1)M \rightarrow \infty$. Hence, $T(x[n])$ is not necessarily bounded. Thus, **not stable**.

(c) $T(x[n]) = \sum_{k=n-n_0}^{n+n_0} x[k]$

- To check the stability:

$$|T(x[n])| = \left| \sum_{k=n-n_0}^{n+n_0} x[k] \right|$$

If $x[n]$ is bounded, i.e., $|x[n]| \leq M$, then:

$$\left| \sum_{k=n-n_0}^{n+n_0} x[k] \right| \leq \sum_{k=n-n_0}^{n+n_0} |x[k]| \leq (2n_0 + 1)M$$

This shows that the sum is bounded by $(2n_0 + 1)M$. Hence, $T(x[n])$ is bounded. Thus, **stable**.

(d) $T(x[n]) = x[n - n_0]$

- To check the stability:

$$|T(x[n])| = |x[n - n_0]|$$

If $x[n]$ is bounded, i.e., $|x[n]| \leq M$, then:

$$|x[n - n_0]| \leq M$$

Hence, $T(x[n])$ is bounded. Thus, **stable**.

(e) $T(x[n]) = e^{x[n]}$

- To check the stability:

$$|T(x[n])| = |e^{x[n]}|$$

If $x[n]$ is bounded, i.e., $|x[n]| \leq M$, then:

$$|e^{x[n]}| \leq e^M$$

Hence, $T(x[n])$ is bounded. Thus, **stable**.

(f) $T(x[n]) = ax[n] + b$

- To check the stability:

$$|T(x[n])| = |ax[n] + b|$$

If $x[n]$ is bounded, i.e., $|x[n]| \leq M$, then:

$$|ax[n] + b| \leq |a|M + |b|$$

Hence, $T(x[n])$ is bounded. Thus, **stable**.

(g) $T(x[n]) = x[-n]$

- To check the stability:

$$|T(x[n])| = |x[-n]|$$

If $x[n]$ is bounded, i.e., $|x[n]| \leq M$, then:

$$|x[-n]| \leq M$$

Hence, $T(x[n])$ is bounded. Thus, **stable**.

(h) $T(x[n]) = x[n] + 3u[n + 1]$

- To check the stability:

$$|T(x[n])| = |x[n] + 3u[n + 1]|$$

If $x[n]$ is bounded, i.e., $|x[n]| \leq M$, then for $u[n + 1]$ (unit step function), $u[n + 1]$ is 1 for $n \geq -1$ and 0 otherwise:

$$|x[n] + 3u[n + 1]| \leq M + 3$$

Hence, $T(x[n])$ is bounded. Thus, **stable**.



Prove only the linearity of each signal in mathematical terms



To prove the linearity of each system, we need to verify if the system satisfies the superposition principle. This means that for any two inputs $x_1[n]$ and $x_2[n]$, and any two constants a and b , the system T should satisfy:

$$T(ax_1[n] + bx_2[n]) = aT(x_1[n]) + bT(x_2[n])$$

Let's analyze each system:

(a) $T(x[n]) = g[n]x[n]$ **with $g[n]$ given**

To check linearity:

$$T(ax_1[n] + bx_2[n]) = g[n](ax_1[n] + bx_2[n]) = ag[n]x_1[n] + bg[n]x_2[n] = aT(x_1[n]) + bT(x_2[n])$$

Hence, the system is **linear**.

(b) $T(x[n]) = \sum_{k=n_0}^n x[k]$

To check linearity:

$$T(ax_1[n] + bx_2[n]) = \sum_{k=n_0}^n (ax_1[k] + bx_2[k]) = a \sum_{k=n_0}^n x_1[k] + b \sum_{k=n_0}^n x_2[k] = aT(x_1[n]) + bT(x_2[n])$$

Hence, the system is **linear**.

(c) $T(x[n]) = \sum_{k=n-n_0}^{n+n_0} x[k]$

To check linearity:

$$T(ax_1[n] + bx_2[n]) = \sum_{k=n-n_0}^{n+n_0} (ax_1[k] + bx_2[k]) = a \sum_{k=n-n_0}^{n+n_0} x_1[k] + b \sum_{k=n-n_0}^{n+n_0} x_2[k] = aT(x_1[n]) + bT(x_2[n])$$

Hence, the system is **linear**.

(d) $T(x[n]) = x[n - n_0]$

To check linearity:

$$T(ax_1[n] + bx_2[n]) = ax_1[n - n_0] + bx_2[n - n_0] = aT(x_1[n]) + bT(x_2[n])$$

Hence, the system is **linear**.

(e) $T(x[n]) = e^{x[n]}$

To check linearity:

$$T(ax_1[n] + bx_2[n]) = e^{ax_1[n] + bx_2[n]}$$

This is not equal to $ae^{x_1[n]} + be^{x_2[n]}$ in general.

Hence, the system is **not linear**.

(f) $T(x[n]) = ax[n] + b$

To check linearity:

$$T(ax_1[n] + bx_2[n]) = a(ax_1[n] + bx_2[n]) + b = a^2x_1[n] + abx_2[n] + b$$

This is not equal to $aT(x_1[n]) + bT(x_2[n])$ due to the constant term b .

Hence, the system is **not linear**.

(g) $T(x[n]) = x[-n]$

To check linearity:

$$T(ax_1[n] + bx_2[n]) = ax_1[-n] + bx_2[-n] = aT(x_1[n]) + bT(x_2[n])$$

Hence, the system is **linear**.

(h) $T(x[n]) = x[n] + 3u[n + 1]$

To check linearity:

$$T(ax_1[n] + bx_2[n]) = ax_1[n] + bx_2[n] + 3u[n + 1]$$

This is not equal to $aT(x_1[n]) + bT(x_2[n])$ because the term $3u[n + 1]$ is not scaled by a and b .

Hence, the system is **not linear**.

Here's a summary of the linearity:

System	Linear
(a)	Yes
(b)	Yes
(c)	Yes
(d)	Yes
(e)	No
(f)	No
(g)	Yes
(h)	No



Prove only the time invariance of each signal in mathematical terms



To prove the time invariance of each system, we need to check whether a time shift in the input signal results in the same time shift in the output signal. Specifically, a system T is time-invariant if, for any input $x[n]$ and any shift n_0 , the following condition holds:

$$T(x[n - n_0]) = T(x[n]) \Big|_{n \rightarrow n - n_0}$$

Let's analyze each system:

(a) $T(x[n]) = g[n]x[n]$ with $g[n]$ given

To check time invariance:

$$\begin{aligned} T(x[n - n_0]) &= g[n]x[n - n_0] \\ T(x[n]) \Big|_{n \rightarrow n - n_0} &= g[n - n_0]x[n - n_0] \end{aligned}$$

If $g[n]$ is dependent on n , then:

$$g[n]x[n - n_0] \neq g[n - n_0]x[n - n_0]$$

Hence, the system is **not time-invariant** unless $g[n]$ is independent of n .

(b) $T(x[n]) = \sum_{k=n_0}^n x[k]$

To check time invariance:

$$T(x[n - n_0]) = \sum_{k=n_0}^n x[k - n_0]$$

Let $m = k - n_0$. Then $k = m + n_0$ and the limits change to $m = n_0 - n_0$ to $n - n_0$:

$$\begin{aligned} T(x[n - n_0]) &= \sum_{m=0}^{n-n_0} x[m] \\ T(x[n]) \Big|_{n \rightarrow n - n_0} &= \sum_{k=n_0}^{n-n_0} x[k] \end{aligned}$$

So:

$$\sum_{m=0}^{n-n_0} x[m] \equiv \sum_{k=n_0}^{n-n_0} x[k]$$

Hence, the system is **not time-invariant** because the summation limits change.

$$(c) T(x[n]) = \sum_{k=n-n_0}^{n+n_0} x[k]$$

To check time invariance:

$$T(x[n - n_0]) = \sum_{k=n-n_0}^{n+n_0} x[k - n_0]$$

Let $m = k - n_0$. Then $k = m + n_0$ and the limits change to $m = (n - n_0) - n_0$ to $(n + n_0) - n_0$:

$$T(x[n - n_0]) = \sum_{m=n-2n_0}^n x[m]$$

$$T(x[n]) \Big|_{n \rightarrow n-n_0} = \sum_{k=(n-n_0)-n_0}^{(n-n_0)+n_0} x[k]$$

So:

$$\sum_{m=n-2n_0}^n x[m] \equiv \sum_{k=n-2n_0}^n x[k]$$

Hence, the system is **time-invariant**.

$$(d) T(x[n]) = x[n - n_0]$$

To check time invariance:

$$T(x[n - n_0]) = x[(n - n_0) - n_0] = x[n - 2n_0]$$

$$T(x[n]) \Big|_{n \rightarrow n-n_0} = x[(n - n_0) - n_0] = x[n - 2n_0]$$

Hence, the system is **time-invariant**.

$$(e) T(x[n]) = e^{x[n]}$$

To check time invariance:

$$T(x[n - n_0]) = e^{x[n-n_0]}$$

$$T(x[n]) \Big|_{n \rightarrow n-n_0} = e^{x[n-n_0]}$$

Hence, the system is **time-invariant**.

$$(f) T(x[n]) = ax[n] + b$$

To check time invariance:

$$T(x[n - n_0]) = ax[n - n_0] + b$$

$$T(x[n]) \Big|_{n \rightarrow n-n_0} = ax[n - n_0] + b$$

Hence, the system is **time-invariant**.

$$(g) T(x[n]) = x[-n]$$

To check time invariance:

$$T(x[n - n_0]) = x[-(n - n_0)] = x[-n + n_0]$$

$$T(x[n]) \Big|_{n \rightarrow n-n_0} = x[-(n - n_0)] = x[-n + n_0]$$

Hence, the system is **time-invariant**.

$$(h) \ T(x[n]) = x[n] + 3u[n + 1]$$

To check time invariance:

$$T(x[n - n_0]) = x[n - n_0] + 3u[(n - n_0) + 1]$$

$$T(x[n]) \Big|_{n \rightarrow n - n_0} = x[n - n_0] + 3u[(n - n_0) + 1]$$

Since $u[(n - n_0) + 1] \neq u[n + 1]$ after a time shift, the system is **not time-invariant**.

Here's a summary of the time invariance:

System	Time Invariant
(a)	No (depends on $g[n]$)
(b)	No
(c)	Yes
(d)	Yes
(e)	Yes
(f)	Yes
(g)	Yes
(h)	No



The impulse response $h[n]$ of a linear time-invariant system is known to be zero, except in the interval $N_0 \leq n \leq N_1$. The input $x[n]$ is known to be zero, except in the interval $N_2 \leq n \leq N_3$. As a result, the output is constrained to be zero, except in some interval $N_4 \leq n \leq N_5$. Determine N_4 and N_5 in terms of N_0 , N_1 , N_2 , and N_3 .

Solve this question in mathematical terms



To determine N_4 and N_5 in terms of N_0 , N_1 , N_2 , and N_3 , let's analyze the given information and use the properties of convolution in a linear time-invariant (LTI) system.

Given:

- The impulse response $h[n]$ is non-zero only in the interval $N_0 \leq n \leq N_1$.
- The input $x[n]$ is non-zero only in the interval $N_2 \leq n \leq N_3$.

Required:

Determine the interval $N_4 \leq n \leq N_5$ for which the output $y[n]$ is non-zero.

Convolution and Support:

For an LTI system, the output $y[n]$ is the convolution of the input $x[n]$ and the impulse response $h[n]$:
 $y[n] = (x * h)[n] = \sum_{k=-\infty}^{\infty} x[k]h[n-k]$

The support of $y[n]$ (i.e., the interval where $y[n]$ is non-zero) is determined by the supports of $x[n]$ and $h[n]$. Specifically:

- The minimum value of n for which $y[n]$ is non-zero corresponds to the sum of the minimum values of the supports of $x[n]$ and $h[n]$.
- The maximum value of n for which $y[n]$ is non-zero corresponds to the sum of the maximum values of the supports of $x[n]$ and $h[n]$.

Calculation:

1. Minimum n value (N_4):

- The minimum value of n is the sum of the minimum values of the supports of $x[n]$ and $h[n]$:
 $N_4 = N_0 + N_2$

2. Maximum n value (N_5):

- The maximum value of n is the sum of the maximum values of the supports of $x[n]$ and $h[n]$:
 $N_5 = N_1 + N_3$

Conclusion:

Thus, the output $y[n]$ will be non-zero in the interval $N_4 \leq n \leq N_5$, where:

$$N_4 = N_0 + N_2$$

$$N_5 = N_1 + N_3$$

So, the output $y[n]$ is constrained to be zero except in the interval $N_0 + N_2 \leq n \leq N_1 + N_3$.



If $x[n]$ is zero, except for N consecutive points, and $h[n]$ is zero, except for M consecutive points, what is the maximum number of consecutive points for which $y[n]$ can be nonzero?

Solve this question in mathematical terms



To determine the maximum number of consecutive points for which $y[n]$ can be non-zero, we need to understand the convolution of two signals that are each non-zero over a finite number of points.

Given:

- $x[n]$ is zero except for N consecutive points.
- $h[n]$ is zero except for M consecutive points.

Convolution:

The output $y[n]$ of an LTI system with input $x[n]$ and impulse response $h[n]$ is given by the convolution:

$$y[n] = (x * h)[n] = \sum_{k=-\infty}^{\infty} x[k]h[n-k]$$

Support of $y[n]$:

1. Support of $x[n]$:

- Let $x[n]$ be non-zero for $n = a$ to $n = a + N - 1$. Thus, $x[n]$ is non-zero for N points.

2. Support of $h[n]$:

- Let $h[n]$ be non-zero for $n = b$ to $n = b + M - 1$. Thus, $h[n]$ is non-zero for M points.

Overlapping Interval:

To find the maximum number of points where $y[n]$ can be non-zero, consider the following:

- The first non-zero point in $y[n]$ will be when the first point of $x[n]$ aligns with the first point of $h[n]$.
- The last non-zero point in $y[n]$ will be when the last point of $x[n]$ aligns with the last point of $h[n]$.

The number of non-zero points in the output $y[n]$ will be the sum of the lengths of the non-zero intervals of $x[n]$ and $h[n]$ minus 1, since the overlapping portion counts for the same points:

Maximum number of consecutive points where $y[n]$ can be non-zero = $N + M - 1$

Conclusion:

The maximum number of consecutive points for which $y[n]$ can be non-zero is $\boxed{N + M - 1}$.



Three systems A , B , and C have the inputs and outputs indicated in Figure P2.27-1. Determine whether each system could be LTI. If your answer is yes, specify whether there could be more than one LTI system with the given input-output pair. Explain your answer.

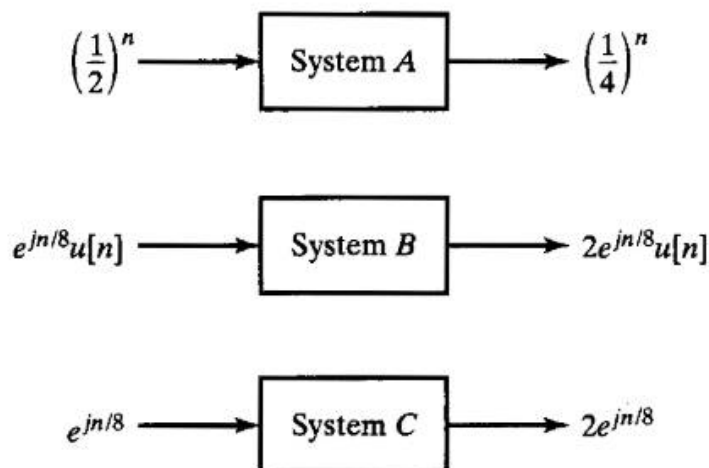


Figure P2.27-1

Give me the answer to this question in mathematical terms



To determine whether each system A , B , and C can be Linear Time-Invariant (LTI), we need to check the input-output relationship and see if it adheres to the properties of linearity and time invariance. Additionally, we need to see if there could be more than one LTI system with the given input-output pair.

System A

Input: $(\frac{1}{2})^n$

Output: $(\frac{1}{4})^n$

To check if System A is LTI, let's consider the impulse response $h[n]$. For an LTI system, the output $y[n]$ is the convolution of the input $x[n]$ and the impulse response $h[n]$:

$$y[n] = x[n] * h[n]$$

For an LTI system, given $x[n] = (\frac{1}{2})^n$, the output $y[n] = (\frac{1}{4})^n$.

If we assume $h[n] = (\frac{1}{2})^n$, then the convolution is:

$$y[n] = (\frac{1}{2})^n * h[n]$$

We need to find $h[n]$ such that:

$$\sum_{k=-\infty}^{\infty} (\frac{1}{2})^k h[n-k] = (\frac{1}{4})^n$$

From this, we can deduce that $h[n]$ must be a scaled and shifted version of the input to produce the required output.

A possible solution is:

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

Then,

$$y[n] = \sum_{k=-\infty}^{\infty} \left(\frac{1}{2}\right)^k \left(\frac{1}{2}\right)^{n-k} = \left(\frac{1}{2}\right)^n \sum_{k=-\infty}^{\infty} \left(\frac{1}{2}\right)^k$$

If $\left(\frac{1}{2}\right)^k$ is a unit impulse, this simplifies to:

$$y[n] = \left(\frac{1}{2}\right)^n \left(\frac{1}{2}\right)^n = \left(\frac{1}{4}\right)^n$$

Thus, System A can be LTI. There could be other impulse responses that satisfy this convolution, so more than one LTI system could produce this input-output pair.

System B

Input: $e^{jn/8} u[n]$

Output: $2e^{jn/8} u[n]$

To check if System B is LTI, let's consider the impulse response $h[n]$. For an LTI system, given $x[n] = e^{jn/8} u[n]$, the output $y[n] = 2e^{jn/8} u[n]$.

If we assume $h[n] = 2\delta[n]$, then the convolution is:

$$y[n] = \sum_{k=-\infty}^{\infty} e^{jn/8} u[k] \cdot 2\delta[n-k]$$

This simplifies to:

$$y[n] = 2e^{jn/8} u[n]$$

So, System B can be LTI with $h[n] = 2\delta[n]$. This is a unique solution for the impulse response to produce the given output, so there is only one LTI system with this input-output pair.

System C

Input: $e^{jn/8}$

Output: $2e^{jn/8}$

To check if System C is LTI, let's consider the impulse response $h[n]$. For an LTI system, given $x[n] = e^{jn/8}$, the output $y[n] = 2e^{jn/8}$.

If we assume $h[n] = 2\delta[n]$, then the convolution is:

$$y[n] = \sum_{k=-\infty}^{\infty} e^{jn/8} \cdot 2\delta[n-k]$$

This simplifies to:

$$y[n] = 2e^{jn/8}$$

So, System C can be LTI with $h[n] = 2\delta[n]$. This is a unique solution for the impulse response to produce the given output, so there is only one LTI system with this input-output pair.

Conclusion:

- **System A** can be LTI and there could be more than one LTI system with the given input-output pair.
- **System B** can be LTI and there is only one LTI system with the given input-output pair.
- **System C** can be LTI and there is only one LTI system with the given input-output pair.

ChatGPT can make mistakes. Check important info.