Imperial College London

MODULE 1 CLASS

Aidan Hogg - 10 October 2019
ELEC96010 (EE3-07): Digital Signal Processing
Department of Electrical and Electronic Engineering

PEER INSTRUCTION

Why 'Peer Instruction'?

1: It forces students to engage in the class

2: Students in the past have given very positive feedback

3: In the exam most students do well in the mathematical questions but clearly have very limited conceptual understanding of the questions they are solving **(plug 'n chug)**

Method:

1: Conceptual question posed - students think quietly on their own and report initial answers on Mentimeter **(3 mins)**

2: Students discuss their answers in small groups **(2 mins)**

3: Explanation/discussion of correct answer **(3 mins)**

Consider the following statements:

1: An LTI system is “BIBO stable”

2: The impulse response is absolutely summable

3: The region of absolute convergence of the transfer function, $H(z)$, includes the unit circle

Which of these statements are equivalent?

A: 1 and 2

B: 2 and 3

C: All of them

ANSWER

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When referring to a “BIBO-stable” system what is meant by the term “bounded”?

A sequence $x[n]$ is bounded iff $\exists B < \infty$ such that

A: $\sum |x[n]| < B$

B: $|x[n]| < B \; \forall \; n$

C: $\sum |x[n]|^2 < B$

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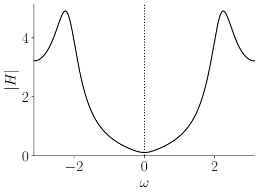
A sequence $x[n]$ is bounded iff $\exists B < \infty$ such that

A: $\sum |x[n]| < B$ (Absolutely summable)

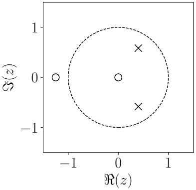
B: $|x[n]| < B \;\forall\, n$ **(Bounded)**

C: $\sum |x[n]|^2 < B$ (Finite Energy)

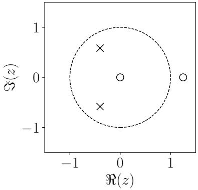
Consider the following frequency response



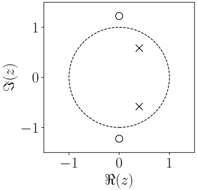
What system gives this frequency response?



A



B



C

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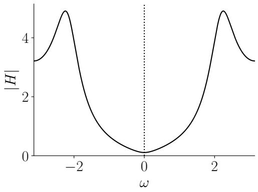

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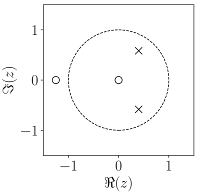
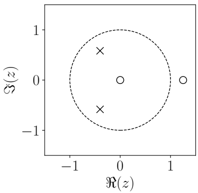
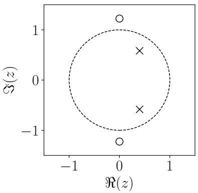


A

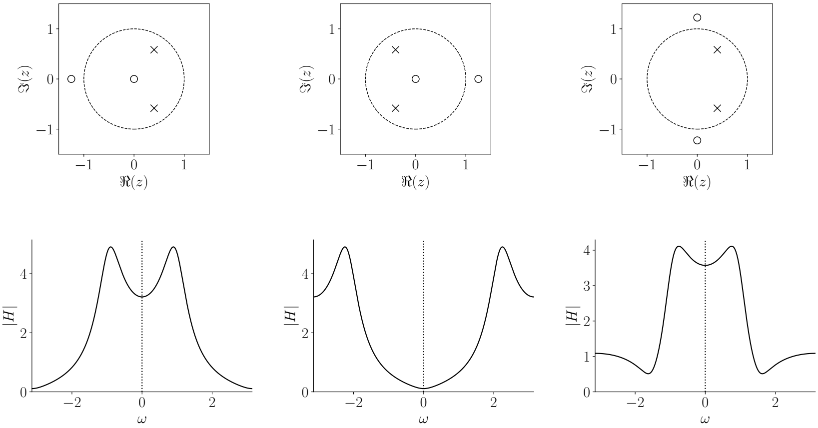


B



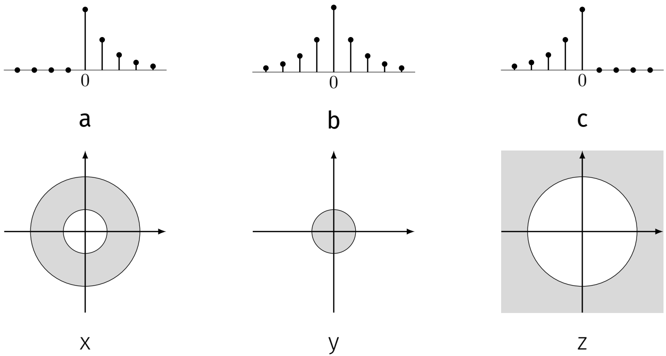
C

Frequency responses:



A B C

GO TO WWW.MENTI.COM AND USE THE CODE 31 98 45



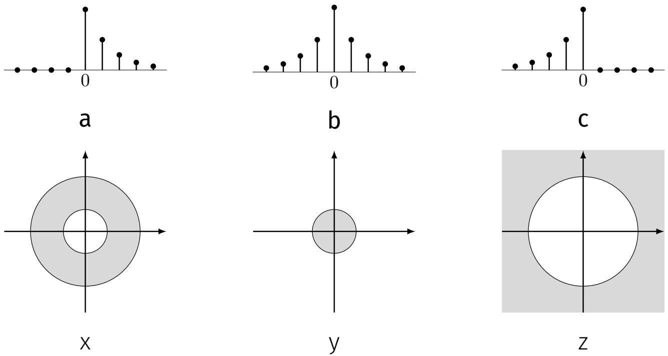
What is the correct mapping between these signals and their ROCs?

A: **a** : x, **b** : y, **c** : z

B: **a** : y, **b** : x, **c** : z

C: **a** : z, **b** : x, **c** : y

ANSWER



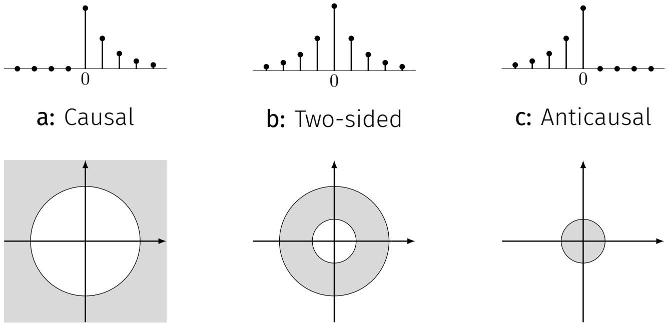
What is the correct mapping between these signals and their ROCs?

A: **a** : x, **b** : y, **c** : z

B: **a** : y, **b** : x, **c** : z

C: **a : z, b : x, c : y**

EXPLANATION



If a right-sided impulse response is also causal what does that imply?

If a left-sided impulse response is also anti-causal what does that imply?

Consider the following sampled sine wave $x[n] = \sin(\omega n)$ for differnt values of ω.

(i) $\omega = \frac{\pi}{4}$
(ii) $\omega = \frac{4}{\pi}$
(iii) $\omega = 4$

What values of ω will make $\sin(\omega n)$ periodic?

A: (i)
B: (ii)
C: All of them

ANSWER

Consider the following sampled sine wave $x[n] = \sin(\omega n)$ for differnt values of ω.

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What values of ω will make $\sin(\omega n)$ periodic?

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C: All of them

A periodic sequence is one where $x[n] = x[n+N]$, therefore, when does $\sin(\omega n) = \sin(\omega(n+N))$.

For periodicity to be true $\sin(\omega n) = \sin(\omega(n+N))$ thus ωN must be a multiple of 2π. Therefore, $\omega N = 2\pi r \implies \frac{\omega}{2\pi} = \frac{r}{N}$.

Which means that $\sin(\omega n)$ is only periodic if $\frac{\omega}{2\pi}$ is rational.

(i) $\omega = \frac{\pi}{4} \therefore \frac{\omega}{2\pi} = \frac{1}{8}$ is rational so the $\sin(\frac{\pi}{4}n)$ is periodic

(ii) $\omega = \frac{4}{\pi} \therefore \frac{\omega}{2\pi} = \frac{2}{\pi^2}$ is irrational so $\sin(\frac{4}{\pi}n)$ is non-periodic

(iii) $\omega = 4 \therefore \frac{\omega}{2\pi} = \frac{2}{\pi}$ is irrational so $\sin(4n)$ is non-periodic

Consider the following systems:

$$H(z) = \frac{0.75}{1 + 0.5z^{-1}} + \frac{1.25}{1 - 1.5z^{-1}} \quad \text{ROC: } 1.5 < |z| \leq \infty$$

$$y[n] = 0.5x[n] + 0.5y[n-1]$$

$$h[n] = -1.75^n u[-n-1]$$

What fact is true about all these systems?

A: They are all causal

B: They are all stable

C: They all have an infinite impulse response

ANSWER

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EXPLANATION

Consider the following systems: | Statements True

$H(z) = \frac{0.75}{1+0.5z^{-1}} + \frac{1.25}{1-1.5z^{-1}}$ ROC: $1.5 < \|z\| \leq \infty$	**A,C**
$y[n] = 0.5x[n] + 0.5y[n-1]$	**A,B,C**
$h[n] = -1.75^n u[-n-1]$	**B,C**

What fact is true about all these systems?

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