Breadth Exam- Fall 2023

ECGR 4124

Quiz Instructions

Question 1 — 4 pts

An LTI system has impulse response defined by $h[n] =$ {5, -3, 6} for $n = \{0, 1, 2\}$.

Determine the output of the system, $y[n]$, when the input, $x[n] = A\delta[n]$ for $A =$-1.

Provide a single number as your answer which is the total of the values of the output, i.e., $\sum_{-\infty}^{\infty} y[n]$.

Question 2 — 3 pts

What are the components one would typically need to construct a digital signal processing system that could take analog signals as input and also output the processed results as an analog signal?

(Choose all that apply)

- [ ] Capacitor
- [ ] Resistor
- [ ] CPU
- [ ] op amp
- [ ] analog to digital converter
- [ ] digital to analog converter
- [ ] inductor

Question 3 — 3 pts

If an input $x(t) = sin(-3\pi t)$ is sampled with a sampling frequency of f_s = 3 samples/sec, what is the discrete frequency of the sampled sinusoidal signal in rad/sample?

Specify your answer with two decimal digits of accuracy.

Question 4

3 pts

Let $x[n]$ denote a sampled signal from a continuous sinusoidal signal $x(t) = sin(2\pi ft)$. For f = 2.7 Hz, and a sampling interval of T = 9 seconds/sample, what the value of $x[3]$?

Keep two decimal digits for result.

Question 5

3 pts

How many signals listed below are periodic?

$x[n] = \sin\left(\frac{6\pi}{7}n + 1\right)$

$x[n] = \cos\left(\frac{n}{8} - \pi\right)$

$x[n] = \cos\left(\frac{\pi}{8}n - \frac{\pi}{3}\right)$

$x[n] = 1$

Note: Constants DO repeat their values.

- ○ 3
- ○ 1
- ○ 0
- ○ 4

Question 6

5 pts

If $z_1 = 1 - j\,2\omega$ and $z_2 = 2 + j\,4\omega$ simplify the ratio $\frac{z_1}{z_2^*}$ where $*$ denotes conjugation.

- $\frac{\sqrt{5}}{2\sqrt{2}} e^{jtan^{-1}(2\omega)}$
- $\frac{\sqrt{5}}{2\sqrt{2}} e^{-jtan^{-1}(2\omega)}$
- $\frac{1}{2}$
- None of the provided solutions are correct.

Question 7

5 pts

(True or False) The signal $x[n] = \sin(A\pi^2 n)$ is periodic.

- True
- False

Question 8

3 pts

Which of the functions below are equivalent to the function $\sum_{k=-\infty}^{-4} \delta[n+k]$?

- $\mu[n-4]$
- $\mu[n]$
- $\mu[n+4]$
- None of the above

Question 9

3 pts

What is the angle (in radians) of the complex number $z = -3$?

- π
- 0
- 2π
- The correct answer is not provided

Question 10

5 pts

What is the list of values of $x[n] = e^{-j5\pi n}$ for $n = 0, 1, 2, 3$?

- ○ $1, -1, 1, -1$
- ○ $-1, 1, -1, 1$
- ○ $0, 1, -1, 0$
- ○ None of the above

Question 11

3 pts

If $x[n] = 3\delta[n+1] + 2\delta[n-2] + 5e^{-n}\mu[n-1]$ what is the value of $x[n]$ at $n = 0$?

- ○ $+\infty$
- ○ 0
- ○ 5
- ○ The correct answer is not provided

Question 12

4 pts

The lengths of two discrete time sequence $x_1\,[n]$ and $x_2\,[n]$ are 7 and 7 respectively. The maximum length of a sequence $x_1\,[n] * x_2\,[n]$ is _____

Question 13

4 pts

Let $x\,[n] = \sin(\frac{1}{b}\pi n)$. Given that b = 19, determine the fundamental period of $x\,[n]$.

Question 14

3 pts

Given the signal $x[n] = \mu[n - a]$ where a =6, determine the moment that this signal changes from 0 to 1.

Question 15

3 pts

Given the system having Discrete Time Fourier Transform as shown below:

$$Y\left(e^{j\omega}\right) + e^{-j\omega}Y\left(e^{j\omega}\right) = X\left(e^{j\omega}\right) + e^{Bj\omega}X\left(e^{j\omega}\right)$$

Given that B=4, indicate if the system is causal using a (0,1) answer as indicated below.

Answer with a number [0,1] where:

1 = Yes the system is causal.

0 = No the system is not causal.

Question 16

4 pts

Consider a system with input $x[n]$ and output $y[n]$. The input-output relation for the system is defined by the following two properties:

1. $y[n] - ay[n-1] = x[n]$
2. $y[0] =$ -1

Answer with a number [0,1] where:

1 = Yes the system is linear and time invariant.

0 = No the system is not linear and time invariant.

Question 17

5 pts

Consider a system with input $x[n]$ and output $y[n]$. The input-output relation for the system is defined by the following two properties:

1. $y[n] - By[n-1] = Ax[n]$

2. $y[0] =$ -2

Given that B=-0.1 and A=-2, indicate if the system is stable using a (0,1) answer as indicated below.

Answer with a number [0,1] where:

1 = Yes the system is stable.

0 = No the system is not stable.

Question 18

5 pts

If $X[25] = 1 - j$ is the value of the DFT at index $k = 25$. What is the phase of response at $k = 25$?

- $\frac{\pi}{4}$
- $\frac{7\pi}{4}$
- π
- None of the provided answers are correct.

Question 19

4 pts

If $x[n] = e^{-j\omega_0 n}$ then the DTFT of $x[n]$, $X\left(e^{j\omega}\right)$ is:

- $\delta(\omega - \omega_0)$
- $\sum_{k=-\infty}^{\infty} 2\pi\delta(\omega - \omega_0 + 2\pi k)$
- $\sum_{k=-\infty}^{\infty} 2\pi\delta(\omega + \omega_0 + 2\pi k)$
- None of the provided answers are correct.

Question 20

3 pts

If $x(t) = \cos(70\pi t)$ is sampled with a sampling period of $T = \frac{1}{70}$ and $X[k]$ is the 101-point DFT of $x[n]$, i.e., $x[n] \leftrightarrow X[k]$. What index, k, of the DFT is closest to the frequency of the input sinusoid $x[n]$?

- ○ 0
- ○ 48
- ○ 52
- ○ 50

Question 21

5 pts

If $x(t) = \cos(300\pi t)$ is sampled with a sampling period of $T = \frac{1}{150}$ seconds/sample, what is the equation for $x[n]$?

- ○ 1
- ○ $\cos(2n)$
- ○ $\cos(\pi n)$
- ○ none of the above

Question 22

3 pts

A system that aliases frequencies is LTI?

- ○ True
- ○ False

Question 23

5 pts

Given the signal below

$$x(t) = 5cos(100\pi t) + 10cos(200\pi t) - 15cos(300\pi t)$$

which of the following sample rates is the lowest rate that also avoids aliasing?

- ○ 300 Hz
- ○ 600 Hz
- ○ 200 Hz
- ○ 300π Hz

Question 24

4 pts

Indicate if the system $h[n] =$-1$^{n}u[\ n-$ (-1)] is stable.

Answer with a number [0,1] where:

1 = Yes the system is stable.

0 = No the system is not stable.

Question 25

8 pts

Calculate the output signal by convolving the system, $h[n]$, and the input, $x[n]$, as provided below:

$$x[n] = u[n]$$

$$h[n] = a^{n}u[n]$$

where $a = 0.2$.

Using your formula for the solution, determine the output at a specific sample index n =3 by calculating y[3] at that sample index.

To obtain the result with the required accuracy, you should find the closed expression of $y[n]$ then substitute the value of n to it.

Specify your answer with two decimal digits of accuracy.