Quiz 2 – Digital Signal Processing

Name:

Circle or write the correct answer.

1. Consider a continuous time signal x(t) that is sampled at 2 Hz to get a discrete time signal x(n). When taking the DTFT of x(n), the digital frequency $\omega = \pi/4$ corresponds to an analog frequency of
   (A) 0 Hz
   (B) 0.25 Hz
   (C) 0.5 Hz
   (D) 0.75 Hz
   (E) 1 Hz
   (F) 2 Hz

2. Consider a continuous time signal given by $x(t) = \cos(2 \pi f t)$. It is sampled at $f_s = 100$ Hz or equivalently at a sampling period of $T_s = 0.01$ seconds/sample to get a discrete time signal $x(n) = \cos(2 \pi f n T_s)$. If f = 20 Hz, let the sampled discrete time signal be denoted by $x_1(n)$. If f = 80 Hz, let the sampled discrete time signal be denoted by $x_2(n)$. Which of the following statements is true?
   (A) $x_1(n) = x_2(n)$
   (B) $x_1(n) = - x_2(n)$
   (C) $x_1(n) = 4x_2(n)$
   (D) $x_1(n) = - 4x_2(n)$
   (E) $4x_1(n) = x_2(n)$
   (F) $-4x_1(n) = x_2(n)$

3. Consider the signal $x(n) = a^{|n|}$ for $-\infty \leq n \leq \infty$. If $|a| < 1$ ($a \neq 0$) and $X(e^{j\omega})$ is the DTFT of x(n), $X(e^{j0})$ equals

   (A) $\frac{1+a}{1-a}$

   (B) $\frac{1-a}{1+a}$

   (C) $\frac{1+a}{(1-a)^2}$

   (D) $\frac{1-a}{(1+a)^2}$

   (E) 1

4. A linear and time-invariant (LTI) system has an impulse response h(n) = u(n) where u(n) is the unit-step. The input to the system is x(n) = u(n) and the output is y(n). An expression for y(n) is given by
   (A) y(n) = 0
   (B) y(n) = u(n)
   (C) y(n) = n u(n)
   (D) y(n) = (n + 1) u(n)

5. What is the power of the signal $x(n) = \cos(\pi n/2)$?
   (A) 0
   (B) 0.5
   (C) 1
   (D) 1.5
   (E) 2
   (F) 4

6. Consider x(n) with a DTFT $X(e^{j\omega}) = \cos(3\omega)$. What is the value of

$$\sum_n (-1)^n \, x(n) \;\; ?$$

(A) 3
(B) 2
(C) 1
(D) 0.5
(E) 0
(F) -0.5
(G) -1
(H) -2
(I) -3

7. Let the DTFT of $a^n u(n)$ (u(n) is the unit-step, $|a| < 1$ and $a \neq 0$) be $A(e^{j\omega}) = 1/(1 - a\, e^{-j\omega})$. What is the DTFT of $x(n) = a^n u(n - 2)$?

(A) $\frac{1}{1-ae^{-j\omega}}$

(B) $\frac{e^{-j2\omega}}{1-ae^{-j\omega}}$

(C) $\frac{a^2e^{-j2\omega}}{1-ae^{-j\omega}}$

(D) 1

8. The DTFT of the real discrete time signal $x(n) = n\,5^n\,[u(n) - u(n-4)]$ ($u(n)$ is the unit-step)
   (A) does not exist
   (B) exists but is not periodic in 2π
   (C) has a real part of 0 when $\omega = \pi$
   (D) has a nonzero real and imaginary part when $\omega = \pi/2$

9. Determine the value of

$$\sum_{n=-\infty}^{\infty} \delta(n+3)(n^2+n)$$

   (A) 6
   (B) 12
   (C) 0
   (D) ∞

10. Consider a system given by $y(n) = S[x(n)] = (k^2 - 3k - 4)\log(x(n)) + x(n)$ where k is a fixed real constant, log refers to the natural logarithm and $x(n) > 0$ for all n. For what values of k will the system be linear?
    (A) k = 1 and k = 4
    (B) k = 2 and k = 3
    (C) k = 4 and k = 5
    (D) k = -1 and k = 4