Digital Signal Analysis

ASSIGNMENT - 02

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

   a) $x[n] = \cos(0.03\pi n)$

   b) $x(n) = \cos\left(\frac{\pi n^2}{4}\right)$

   c) $x(n) = 5$

   d) $x(n) = \cos(5\pi n) + \cos(4/5\,\pi n)$

   e) $x(n) = \sin(5\pi n + 2)$

   f) $x(n) = \cos(n + \pi)$

2. Find the odd and even parts of the following -

   a) $e^{(a\pi n/b)j}$

   b) $a\cos(b\pi n + 1)$.

3. Determine whether the following signals are energy or power signals.

   a) $x(n) = (1/4)^n u(n)$

   b) $x(n) = a^n u(n)$, $a \in R$

   c) $x(n) = a^n \delta(n)$, $a \in R$.

   d) $x(n) = \sin\left(\frac{n\pi}{4}\right)$.

4. Consider the analog signal $x_a(t) = 5\sin 200\pi t$. Find the minimum sampling rate required to avoid aliasing. If $F_s = 250$ Hz, indicate the discrete-time signal after sampling.

5. Consider the analog signal $x_a(t) = 3\cos 80\pi t + 5\sin 40\pi t - 10\cos 160\pi t$. Find the Nyquist rate for this signal, and the sampled version of the analog signal at this frequency. Sketch the waveform and indicate the sampling points.

6. Let $x_a(t) = 5\cos 2000\pi t + 5\sin 6000\pi t - 7\cos 12000\pi t$ be an analog signal. Find the minimum sampling frequency. If $F_s = 5000$ samples/sec, what is the discrete-time signal obtained after sampling, and the analog signal that can be reconstructed from the samples.

7. Consider the analog waveform $x(t)$, where

$$x(t) = \begin{cases} \sin\left(\frac{\pi t}{4}\right), & 0 \le t \le 4. \\ 4 - t, & 4 \le t \le 6 \\ t - 8, & 6 \le t \le 9 \\ 1, & 9 \le t \le 10. \end{cases}$$

It is sampled at 1000 Hz and quantized with a 2-bit quantizer with input range $-2V$ to $2V$.

a. Indicate the sample points

b. Sketch the quantisation intervals and the corresponding digital words.

c. Sketch the digital word assigned to each sample point.

d. What is the stream of bits generated after the quantisation is complete?

e. What is the resulting bit-rate?

f. What is the quantisation error?

g. Report all the above for 3-bit quantization

h. Which quantization is better among 2-bit & 3-bit. Provide reason.

8. Test the following systems for time invariance

a. $y(n) = \frac{a}{x(n)}$

b. $y(n) = 3x(n) + 5x(n-2)$

c. $y(n) = x(-n)$.

d. $y(n) = nx(n)$.

e. $y(n) = x(5n)$.

9. Test the following systems for linearity.

a. $y(n) = 5x(n) + 7x(n-1)$.

b. $y(n) = 4x(n) - \frac{9}{x(n-1)}$

c. $y(n) = \sum_{m=0}^{N} b_m x(n-m) - \sum_{m=1}^{N} d_m x(n-m)$

10. Test the following systems for causality.

a. $y(n) = ax(n) + bx(n-1)$

b. $y(n) = ax(n-1) + bx(n+1)$

c. $y(n) = \sum_{k=0}^{\infty} x(n-k)$

d. $y(n) = \sum_{k=0}^{\infty} x(n+k)$.