Tutorial No. – 02

question no. 1:– Consider an analog signal

$x_a(t) = 3 \cos(100\pi t)$

a) Determine the minimum sampling rate required to avoid aliasing.

b) Suppose that the signal is sampled at the rate $F_s = 200\,Hz$. What is the discrete-time signal obtained after sampling?

c) Suppose that the signal is sampled at the rate $F_s = 75\,Hz$. What is the discrete-time signal obtained after sampling?

d) What is the frequency $0 < F < F_s/2$ of a sinusoid that yields samples identical to those obtained in part (c)?

question no. 2:– Consider the analog signal

$x_a(t) = 3\cos(2000\pi t) + 5\sin(6000\pi t) + 10\cos(12000\pi t)$

(a) What is the Nyquist rate for this signal?

(b) Assume now that we sample this signal using a sampling rate $F_s = 5000$ samples/sec. What is the discrete-time signal obtained after sampling?

(c) What is the analog signal $y_a(t)$ that we can reconstruct from the samples, if we use ideal interpolation?

question no.3 :-

Consider the signal $x(n) = a^n u(n) \quad 0 < a < 1$

Determine the spectrum $|X(e^{jw})|$ Vs. w.

The spectrum of this signal is sampled at frequencies $w_k = \frac{2\pi k}{N}$; $k = 0, 1, --, N-1$; and now determine the spectrum $|X(w_k)|$ Vs. k, when $N = 5$.

question no. 4 :-

The discrete-time signal $g_s(t)$ is considered to be the input signal for an LTI system with impulse response $h(t)$. The corresponding system output is $s(t)$.

where ;

$$g_s(t) = \sum_{n=-\infty}^{\infty} g(nT_s)\, \delta(t - nT_s) \quad \xleftrightarrow{FT} \quad G_{r_s}(F)$$

with $T_s = \frac{1}{F_s}$ = sampling interval

$$h(t) = \begin{cases} 1 & 0 \leq t \leq T \\ 0 & t < 0 \text{ ; and } t > T \end{cases}$$

Determine mathematical expressions for the output signal $s(t)$ and $S(F)$, where F is the frequency in continuous-time domain and F_s is the sampling frequency / rate.

Hint :- $G_{r_s}(F) = F_s \sum_{m=-\infty}^{+\infty} G_r(F - mF_s)$

$H(F) = ?$