Tutorial No. – 01

question no. 01 → Consider the discrete-time signal

$$x[n] = 1 + \sin\left(\frac{2\pi n}{N}\right) + 3\cos\left(\frac{2\pi n}{N}\right) + \cos\left(\frac{4\pi}{N}n + \pi/2\right)$$

The signal is periodic with period N.
Obtain Fourier series coefficients for $x[n]$.
Plot magnitude and phase of spectral coefficients.

question no. 02 → If input to an LTI system be the unit-step signal, then determine impulse response of this system.

(a) in discrete-domain
(b) in continuous-domain

question no. 03 → Consider an LTI system that successively takes a two-point average of input values, such that its output is

$$y(n) = \frac{1}{2}\left[x(n) + x(n-1)\right]$$

Determine impulse response of this system $h[n]$ and its frequency response $H[e^{jw}]$. Plot magnitude response $|H(e^{jw})|$ w.r.t. w.

question no. 04 → If the output of an LTI system is

$$y[n] = \frac{1}{3}\left[x(n-1) + x(n) + x(n+1)\right],$$ then determine the impulse response $h[n]$ and its frequency response $H[e^{jw}]$. Plot $|H[e^{jw}]|$ w.r.t. w.

question no. 05 → Obtain Fourier-transform $X[j\Omega]$ for the following impulse train (in continuous-time domain)

$$x(t) = \sum_{k=-\infty}^{+\infty} \delta(t - kT)$$

which is periodic with period T. Plot its magnitude response w.r.t. Ω.

question no. 06 → Obtain Fourier-transform $X[e^{j\omega}]$ for the following impulse train (in discrete-time domain).

$$x[n] = \sum_{k=-\infty}^{+\infty} \delta(n - kN)$$

which is periodic with period N. Plot its magnitude response w.r.t. ω.

question no. 07 → Let

$$x_{(k)}[n] = \begin{cases} x(n/k) & \text{if } n \text{ is the multiple of } k \\ 0 & \text{if } n \text{ is not the multiple of } k \end{cases}$$

Here, k is a positive integer. Determine its discrete-time Fourier-transform.

Note :- $x[n] \xleftrightarrow{FT} X[e^{j\omega}]$

question no. 08 → Repeat question no. 04, if

$$y[n] = \frac{x[n] - x[n-1]}{2}$$