Q1. Mark the following statements as (T)rue or (F)alse. (15)

a. Convolution in time domain corresponds to multiplication in frequency domain. ( )
b. FIR filter has a linear phase response. ( )
c. “\[ h[n] = \delta[n] - \delta[n-1] \]” defines a smoothing filter. ( )
d. Fourier transform assumes that the analysed signal is periodic. ( )
e. \( x(t) = t^3 \) represents a Linear Time Invariant (LTI) system. ( )

Q2. Frequency response of a LTI filter is given as \( H(e^{j\omega}) = 3 - e^{-j\omega} - 2e^{-j2\omega} \)

a. Determine the system function \( H(z) \) for this sytem. (05)
b. Determine zeros and poles for the system function. (05)
c. What is the output if the input is \( x[n] = \delta[n] + \delta[n-2] \)? (05)
Q3. An LTI system output is given as \( y[n] = 3x[n] - x[n - 1] + 3x[n - 2] \)

a. Determine the impulse response of that system \( h[n] \). (04)
b. Find the output \( y[n] \) if the input \( x[n] \) is a function defined by the following figure? (07)
c. Obtain an expression of the frequency response of this system. (05)
d. Sketch the frequency response (magnitude and phase) as a function of the frequency. (04)
Q4. An $x(t)$ function is given as $x(t) = 2 + \cos\left(\frac{2\pi}{3} t\right) + 4 \sin\left(\frac{5\pi}{3} t\right)$

a. Determine the minimum sampling frequency (Nyquist rate) to sample $x(t)$

b. Find $x[n]$ after $x(t)$ is sampled at Nyquist rate.

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Q5. Filter coefficients of an FIR system are given as $\{b_k\} = \{1, -2, 1\}$

a. What is the filter order (M) and filter length (L).

b. Determine the output signal $y[n]$ when the input signal is $x[n] = 2 + \cos(0.4\pi n)$

c. What does this filter do? Briefly explain.
Q6. A periodic function $x(t)$ is given by the following equation.

a. Plot the function $x(t)$.  

\[ x(t) = \begin{cases} 
+1 & 0 < t < 1 \\
-1 & 1 < t < 2 
\end{cases} \]

b. Determine signal period and frequency.  

c. Find the first four Fourier Transform components.  

d. Plot the frequency spectrum.