## QUESTIONS

Q1. Find frequency response and plot magnitude and phase spectra of the LTI-casual system

$$
y(n)=x(n)+2 x(n-2)+x(n-4)
$$

Q2. One period of a periodic signal is given in the following. Find Fourier series coefficients of this signal.

| $n$ | 0 | 1 | 2 | 3 | 4 | 5 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| $x(n)$ | 3 | 2 | 1 | -1 | -2 | -3 |

Q3. A continuous-time signal $x(t)=e^{-t} u(t)$ is sampled at a sampling rate $f_{s}=4 \mathrm{~Hz}$. Obtain its samples, $\chi\left(n / f_{s}\right)$, for $n=0,1,2, \ldots, 7$. Assume that the samples are zero for $n>7$. Compute $x\left((n+1 / 2) / f_{s}\right)$ for $\mathfrak{n}=0,1,2, \ldots, 7$ using the function (continuous-time signal) itself and the sinc interpolation formula
$x(t)=\sum_{n=-\infty}^{\infty} x(n) \operatorname{sinc}\left(f_{s} t-n\right)$

Q4. Construct a 4-bit $(R=4)$ uniform quantizer for the input range $[-A, A) \quad(A>0)$. Note that

$$
\begin{aligned}
& \mathrm{L}=2^{\mathrm{R}}, \quad \Delta=\frac{2 A}{\mathrm{~L}}, \quad \mathrm{~A}=\frac{\mathrm{L}}{2} \Delta \\
& \xi_{\mathrm{k}}=[(\mathrm{k}-\mathrm{L} / 2) \Delta,(\mathrm{k}+1-\mathrm{L} / 2) \Delta), \quad \mathrm{k}=0,1,2, \ldots, \mathrm{~L}-1 \\
& \mathrm{q}_{\mathrm{k}}=(\mathrm{k}+1 / 2) \Delta-\mathrm{L} \Delta / 2
\end{aligned}
$$

Q5. Consider an LTI-casual system with an impulse response $h(n)=a^{n} u(n)$, and $a \in \mathbb{C}$.
a) Show that the system is stable if $|\mathfrak{a}|<1$.
b) Demonstrate that the system is described by following first order difference equation.

$$
y(n)-a y(n-)=x(n)
$$

c) Suppose that the following first order systems are cascaded (connected in series).

$$
\begin{array}{ll}
w(n)-a w(n-1) & =x(n) \\
y(n)-b y(n) \text { is the input, } w(n) \text { is the output } \\
y(n-1) & =w(n) \\
w(n) \text { is the input, } y(n) \text { is the output }
\end{array} \quad(b \neq a)
$$

Show that this cascaded system is equivalent to the following second order LTI-causal system
$y(n)-(a+b) y(n-1)+a b y(n-2)=x(n)$
d) Find impulse response of this system.
e) Prove that above second order system is stable if roots of its characteristic equation are inside the unit circle of the complex plane.

