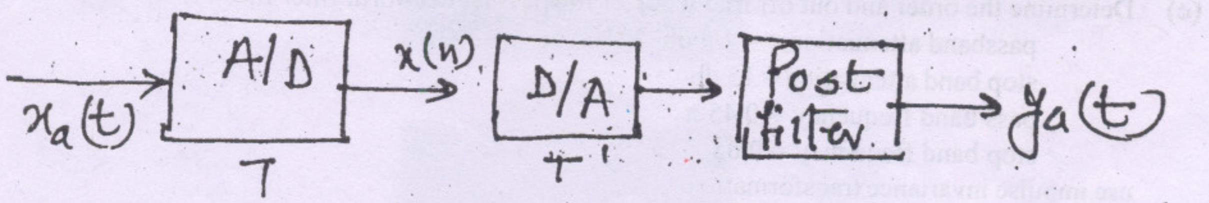
N.B. : (1) Question No. **1** is **compulsory.**
(2) Attempt any **four** questions out of remaining **six.**
(3) **Figures** to the **right** indicates **full** marks.
(4) Assume **suitable data** if **necessary**.

1. (a) Compare Recurrsive and non-recurrsive filter. **20**
(b) Test Linearity and time invariance of following system :—
(i) $y(n) = a \cos [x(n)] + b$. (ii) $y(n) = (n + 1)\, x(n)$.
(c) Using DIF-FFT algorithms find 1 DFT of $x(k) = \{ 10 - 2 + 2j, -2, -2 - 2j \}$.
(d) Find Z-transform of $x(n) = (n + 1)\, a^n\, u(n)$. Specify its ROC.

2. (a) **Consider a simple signal processing system as shown in figure. The sampling period of A/D and D/A convertor are T = 5 ms and T = 1 ms respectively. Determine the output $y_a(t)$ of the if input is $x_a(t) = 3 \cos 100\,\pi t + 2 \sin 250\,\pi t$. The post filter removes any frequency component above Fs/2.** **10**



(b) Determine the Convolution of following pairs of signals using Z-transform— **10**
(i) $x_1(n) = \left(\frac{1}{4}\right)^n n(n-1)$

$x_2(n) = \left[1 + \left(\frac{1}{2}\right)^n\right] u(n)$

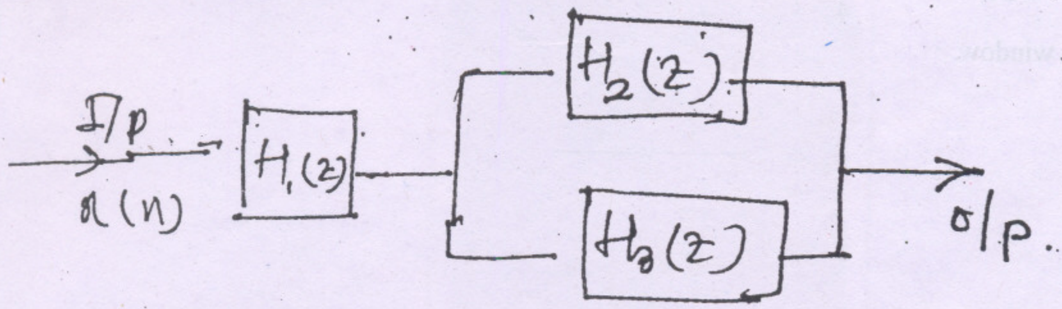
(ii) $x_1(n) = nu(n)$
$x_2(n) = 2^n u(n-2)$.

3. (a) Show Pole zero diagram with arbitrary pole-zero values for an IIRfilter, which has damped Sinusoidal impulse response. Justify your answer. **6**
(b) $x_1(n)$ and $x_2(n)$ are two 8 point real sequences. $x_2(n)$ is time-reversed version of $x_1(n)$. **8**

Let $x_1(k) = x_R'(k) + x_I'(k)$

where R and I represents real and imaging part of DFT.
If $x(n) = x_1(n) + x_2(n)$. Withouts performing any DFT operation, find $x(k)$.
(c) Let $x_1(n) = [\, x_0, x_1, x_2, x_3 \,]$ and $x_1(k) = [\, x_1(0), x_1(1), x_1(2), x_1(3) \,]$. If $x_2(n) = [\, x_0, 0, x_1, 0, x_2, 0, x_3, 0 \,]$. Find $x_2(k)$ using results of $x_1(k)$. State the properly used. Verify the properly. **6**

4. A Discrete time LTI causal system is shown in **figure.**



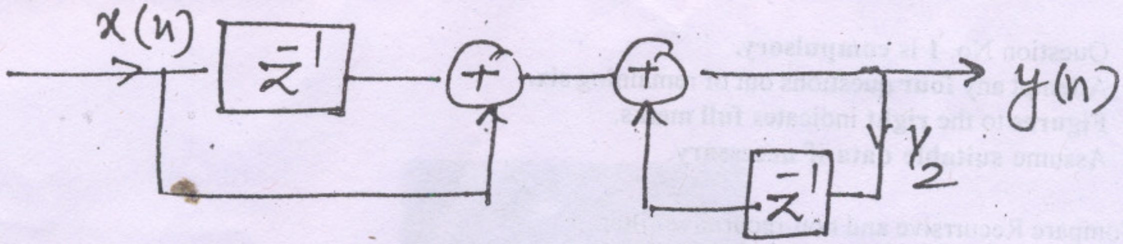
The poles and zeros of individuals modules are tabulated below—

Module	Zero Location	Role Location	Gain
$H_1(z)$	− 0·2	− 0·4	1
$H_2(z)$	—	− 0·2	$-1/3$
$H_3(z)$	—	0·4	$4/3$

(i) Find transfer function H(z) of total system. **5**
(ii) Find the difference Equation of system. **3**
(iii) Show direct form I, II and parallel form of realisation. **6**
(iv) Find impulse response of system. **3**
(v) Find step response of system. **3**

[TURN OVER

5. (a) Consider the system as shown in **figure**— **8**



(i) Determine its impulse response h(n).

(ii) Show that h(n) is the convolution of following signals.

$$h_1(n) = \delta(n) + \delta(n-1)$$

$$h_2(n) = \left(\frac{1}{2}\right)^2 u(n).$$

(b) Derive the expression for the order of Butterworth filter. **4**

(c) Determine the order and out off frequency of lowpass Butterworth filter if. **8**

passband attenuation = – 1·5 db

stop band attenuation = 15 db

pass band frequency = 0·45 π

stop band frequency = 0·65 π

use impulse invariance transformation.

6. (a) Consider the following analog sinusoidal signal $x_a(t) = 3 \text{ Sin } (100 \pi t)$ **12**

(i) Sketch the signal for $0 \le t \le 30$ ms.

(ii) The signal is sampled with a sampling period Fs = 300 samples/s. Determine the frequency of resulting discrete the signal.

(iii) Compute the sample value in one period of x(n). Sketch x(n) on the same diagram with $x_a(t)$. What is period of discrete time signal in milisecond.

(iv) Can you find a sampling rate Fs such that signal reduces to its peak value of 3 ? What is minimum value of Fs suitable for the same.

(b) Determine zero state and zero-input response for a system. **8**

$$y(n) = -0{\cdot}1\, y(n-1) + 0{\cdot}2\, y(n-2) + x(n)$$

where $x(n) = ({}^1/_3)^n\, u(n)$ and $y(-1) = y(-2) = 1$.

7. (a) Is the following filter is a Linear phase filter, if— **5**

$$H(z) = 1 - z^{-1} + z^{-3} - z^{-4}$$

If yes, draw the phase reponse to prove it.

(b) Derive a relation between auto corelation of input, impulse response of system and an auto corelation of output. **5**

(c) Design a Linear phase FIR filter with the following specifications— **10**

$$H_d(w) = 0 \quad 0 \le |w| \le \pi/4$$

$$= 2e^{-j\,3/2\,w} \quad \frac{\pi}{4} < |w| < \pi.$$

Use Hamming window.