Roll No.:.....

National Institute of Technology, Delhi

Name of the Examination: B. Tech.

Branch	**: B.Tech (ECE)**	**Semester**	**: VI**
Title of the Course	**: Digital Signal Processing**	**Course Code**	**: ECB 352**

Time: 3 Hours **Maximum Marks: 50**

Note : Attempt all questions from Section-A, any four questions from Section-B and any two questions from Section-C.

SECTION- A [10 X 1 = 10 MARKS]

A.1 What is Gibbs phenomenon?

A.2 Define ROC.

A.3 State initial and final value theorem of Z-transform.

A.4 Determine whether the given system is causal or stable or both?

$$H(z) = \frac{3+z^{-1}}{1+z^{-1}-\frac{4}{9}z^{-2}}$$

A.5 What is frequency warping?

A.6 Find the energy of the given discrete time signal.

$$x(n) = \begin{cases} 4n^2 & 1 \le n \le 3 \\ 0 & otherwise \end{cases}$$

A.7 Give the classification of discrete-time signals with example.

A.8 Find the linear convolution using graphical method only.

$$x(n) = 2\delta(n+1) + \delta(n-2)$$
$$h(n) = 2^n, \quad for \quad -1 \le n \le 1$$

A.9 Compare the Impulse invariant method and bilinear transformation method of IIR digital filter design.

A.10 Determine the inverse Z-transform of $X(z) = 2 + 3z^{-1} + 4z$.

SECTION- B [4 X 5 = 20 MARKS]

B.1 Realize the following system function in **(a)** Direct form **(b)** Cascade form

$$H(z) = 1 + \frac{3}{4}z^{-1} + \frac{17}{8}z^{-2} + \frac{3}{4}z^{-3} + z^{-4}$$

B.2 A system function is specified by its transfer function H(z) given by,

$$H(z) = \frac{z(z-1)(z-2)(z+1)}{\left[z-\left(\frac{1}{2}+j\frac{1}{2}\right)\right]\left[z-\left(\frac{1}{2}-j\frac{1}{2}\right)\right]\left(z-\frac{j}{4}\right)\left(z+\frac{j}{4}\right)}$$

Realize the system function in direct form-II.

B.3 **(a)** State and proof circular time shift property of DFT.
(b) If X(k) is four point DFT of x(n) = {1,2,3,4}, then without performing DFT and IDFT, determine the signal values which has DFT X(k-2).

B.4 Find the linear convolution of the sequence x(n) and h(n) using DFT

$$x(n) = \{1, 0, 2\} \quad \& \quad h(n) = \{1, 1\}$$

B.5 Find the Z-transform and ROC of

$$x(n) = 2\left(\frac{5}{6}\right)^n u(-n-1) + 3\left(\frac{1}{2}\right)^n u(n)$$

Sketch the ROC and pole-zero location.

SECTION- C [2 X 10 = 20 MARKS]

C.1 Design an linear phase FIR filter using Kaiser window to meet the following specification:

$$0.98 \leq |H(e^{j\omega}) \leq 1.02, \qquad 0 \leq |\omega| \leq 0.19\pi$$
$$|H(e^{j\omega}) \leq 0.01, \qquad 0.21 \leq |\omega| \leq \pi$$

C.2 Design the symmetric FIR low pass digital filter whose desired frequency response is given as

$$H_d(\omega) = \begin{cases} e^{-j\omega\tau}, & for \quad |\omega| \leq 1 \\ 0, & otherwise \end{cases}$$

The length of the filter is 7. Use Hanning window function.

C.3 **(a)** Convert analog system function into digital system function using impulse invariant method.

$$H(s) = \frac{1}{(s+1)(s^2+s+2)}$$

(b) Convert analog system function into digital system function using bilinear transformation method. The digital filter have the resonant frequency π/2.

$$H(s) = \frac{s+0.4}{(s+0.4)^2+4}$$