

7. (a) What is radix-2 algorithm? Compare the computational load of DFT with that of FFT algorithm.
- (b) An 8-point sample sequence is given by $x(n) = \{2, 1, 2, 1, 1, 2, 1, 2\}$.
 Compute 8-point DFT of $x(n)$ using radix-2 DIT-FFT algorithm.
(2 + 2) + 8 = 12

Group – E

8. Determine direct form-I, direct form-II and cascade realization of the following LTI system.

$$H(z) = \frac{z^3 - 8z^2 + 13z - 5}{\left(z - \frac{3}{4}\right)\left(z^2 + z - \frac{1}{2}\right)}$$

(4 + 4 + 4) = 12

9. Design a linear phase FIR band pass filter to pass frequencies in the range 0.4π to 0.65π rad/samples taking 7 samples of Hanning window sequence. Draw the structure of the filter.

(10 + 2) = 12

DIGITAL SIGNAL PROCESSING
(ELEC 3231)

Time Allotted : 3 hrs**Full Marks : 70***Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A**(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) The process of conversion of continuous time signal into discrete time signal is known as,
 (a) aliasing (b) sampling
 (c) convolution (d) deconvolution.
- (ii) The sampling frequency of the signal $x(t) = 4\sin 150\pi t + 2\cos 50\pi t$ should be
 (a) greater than 75 Hz (b) greater than 150 Hz
 (c) less than 150 Hz (d) greater than 50 Hz.
- (iii) The inverse z-transform of $\frac{3}{z-4}$, $|z| > 4$ is
 (a) $3(4)^n u(n-1)$ (b) $3(4)^{n-1} u(n)$
 (c) $3(4)^n u(n+1)$ (d) $3(4)^{n-1} u(n-1)$
- (iv) The ROC of the Z-transform of the sequence $x(n) = u(-n)$ is,
 (a) $|z| > 1$ (b) $|z| < 1$
 (c) no ROC (d) $-1 < |z| < 1$
- (v) In bilinear transformation the analog system with transfer function $H(s) = \frac{0.2}{s+0.9}$ is transformed to a digital system with transfer function,
 (a) $H(s) = \frac{0.2}{\frac{21+z^{-1}}{T1-z^{-1}}+0.9}$ (b) $H(s) = \frac{0.2}{\frac{T(1-z^{-1})}{2(1+z^{-1})}+0.9}$
 (c) $H(s) = \frac{0.2}{\frac{21-z^{-1}}{T1+z^{-1}}+0.9}$ (d) $H(s) = \frac{0.2}{\frac{T(1+z^{-1})}{2(1-z^{-1})}+0.9}$

(vi) The inverse DFT of $x(n)$ can be expressed as

(a) $x(n) = \frac{1}{N} \sum_{k=0}^{N-1} X(k) e^{-\frac{j2\pi kn}{N}}$

(b) $x(n) = \frac{1}{N} \sum_{k=0}^{N-1} X(k) e^{\frac{j2\pi kn}{N}}$

(c) $x(n) = \frac{1}{N} \sum_{n=0}^{N-1} X(n) e^{-\frac{j2\pi kn}{N}}$

(d) $x(n) = N \sum_{n=0}^{N-1} X(k) e^{-\frac{j2\pi kn}{N}}$

(vii) The structure that uses separate delays for input and output samples is

(a) direct form-II

(b) direct form-I

(c) cascade

(d) parallel.

(viii) The normalized transfer function of 3rd order low pass Butterworth filter is

(a) $\frac{1}{s^3 + 1.414s^2 + s + 1}$

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

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

(d) $\frac{1}{s^3+s^2+s+1}$

(ix) The relation between analog and digital frequency is nonlinear in case of

(a) Impulse invariant transformation

(b) Bilinear transformation

(c) Frequency sampling

(d) all of the above.

(x) The width of the main-lobe in rectangular window spectrum is

(a) $\frac{4\pi}{N}$

(b) $\frac{16\pi}{N}$

(c) $\frac{8\pi}{N}$

(d) $\frac{2\pi}{N}$

Group - B

2. (a) State Sampling Theorem.

(b) What do you mean by Nyquist rate?

(c) State whether the signal $x(n) = \left(\frac{1}{3}\right)^n u(n)$ is an energy or a power signal.

(d) Find $y(n) = x\left(\frac{n}{2} - 1\right)$, when $x(n) = \left\{1, \overset{\downarrow}{4}, 2, 6\right\}$.

2 + 2 + 4 + 4 = 12

3. (a) Find the convolution of the following sequences using graphical convolution method. $x(n) = \{2, 5, \underset{\uparrow}{0}, 4\}$ and $h(n) = \{4, \underset{\uparrow}{1}, 3\}$.

(b) Explain whether the following system is linear or not

$$y(n) = 2x(n) + \frac{1}{x(n-1)}$$

(c) Find impulse response of the system described by the difference equation $y(n) - 3y(n-1) - 4y(n-2) = x(n) + 2x(n-1)$

6 + 2 + 4 = 12

Group - C

4. (a) Determine the z-transform and ROC of the discrete time signal

$$x(n) = (0.3)^n u(n) + (0.8)^n u(-n-1)$$

(b) Determine the inverse z-transform of

$$X(z) = \frac{1}{1 - 0.8z^{-1} + 0.12z^{-2}}, \text{ if ROC is } 0.2 < |z| < 0.6.$$

(c) Test the stability of the system whose system equation is given by $y(n) = x(n) + by(n-1)$, where $|b| < 1$.

4 + 4 + 4 = 12

5. (a) Derive the expression of bilinear transformation to transform analog system to digital system.

(b) Explain the mapping of s-plane to z-plane in bilinear transformation. What is frequency warping?

(c) Convert the analog transfer function $H(s) = \frac{s+1}{(s+2)(s+4)}$ into digital transfer function using impulse invariant transformation. Assume sampling time is $T = 1\text{sec}$.

3 + (2 + 1) + 6 = 12

Group - D

6. (a) Find the discrete-time Fourier transform of $x(n) = a^{|n|}$; where $-1 < a < 1$.

(b) Compute 4-point DFT of the sample sequence

$$x(n) = \begin{cases} \frac{1}{3}; & 0 \leq n \leq 2 \\ 0; & \text{otherwise} \end{cases}$$

6 + 6 = 12