Registration No.: | | | | | | | | | | |

Total Number of Pages: **Course: B.Tech/IDD**
Sub Code: EOPC3002

5th Semester Regular Examination: 2025-26
SUBJECT: DIGITAL SIGNAL PROCESSING
BRANCH(S): AEIE, ECE, ETC, ECE
MAX MARKS: 100
TIME: 3 HOURS
Q.Code: U127

Answer Q1 (Part-I) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right-hand margin indicate marks.

Part- I

Q1 **Answer the following questions: (Answer All-10)** **(02 x 10)**

a) What is the ROC in Z-transform of an impulsive signal?

b) How many complex additions and multiplications are there in 8-point DFT and 8-point radix-2 DIT-FFT?

c) Find the circular convolution of $x(n)=\{-5,-2_{\uparrow},-1\}$ and $k(n)=\{1_{\uparrow},2\}$.

d) Define the frequency shifting property of DFT.

e) What is a non-recursive discrete time system?

f) Find the Discrete Fourier Transform of $\delta(n)-\delta(n-2)$.

g) Find Z-transform of $2\delta(n+3)+3u(n-2)$.

h) Find the DFT of $\{4,1,2_{\uparrow},3\}$.

i) Why FIR filters are considered to be stable in comparison to the IIR filters?

j) Find the circular convolution of $u(n)=\{1,1_{\uparrow},2,1\}$ and $h(n)=\{3_{\uparrow},2,1,3\}$.

Part- II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(06 x 08)**

a) Design the direct form structure of the FIR system described by

$$H(z)=1+\frac{1}{2}z^{-1}+\frac{3}{4}z^{-2}+\frac{1}{4}z^{-3}+\frac{1}{2}z^{-4}+\frac{1}{12}z^{-5}.$$

b) Show that for linear phase FIR filter $H(n)=H(N-1-n)$ and $\alpha=\frac{N-1}{2}$.

c) For an analog system response $H(S)=\frac{b}{S+a}$ prove that $H(Z)=\frac{b}{\frac{2}{T}\left(\frac{1-Z^{-1}}{1+Z^{-1}}\right)+a}$.

d) Design the direct form – II filter with transfer function $H(z)=\frac{1+2z^{-1}}{1-4z^{-1}-2z^{-2}}$.

e) If $x[n]$ is an even length sequence with an N-Point DFT $X(k)$, then determine the N-Point DFT of $y[n]=x[n]-x[n-N/2]$ in terms of $X(k)$.

f) Determine the inverse Z-transform of by the partial fraction expansion method $X(z)=\frac{z+2}{2z^2-7z+3}$, if the ROCs are (a) $|z|>3$ and (b) $\frac{1}{2}<|z|<3$.

g) Determine the direct form II realization for the IIR transfer function $H(z)=\frac{0.28z^2+0.319z+0.04}{0.5z^3+0.3z^2+0.17z-0.2}$.

h) Use the overlap add method, to find the long-division convolution between $x(n)=\{2,-1,1,1,2,-1,0,1,2,1,0,1,2,1,2,0,1,1,-1\}$ and $h(n)=\{1,-2,1,-2\}$.

i) For $X(k)=\{36,-4+j9.656,-4+j4,-4+j1.656,-4,-4-j1.656,-4-j4,-4-j9.656\}$ find $x(n)$ using FFT Algorithm.

j) How DIT-FFT can be used in linear digital filtering and signal correlation analysis? Justify your answer with suitable examples.

k) Using partial fraction method, find the inverse z-Transform of the following transfer function, $H(z)=\frac{4z^{-1}-4}{10z^{-2}+7z^{-1}+1}$.

l) Differentiate between symmetric and anti-symmetric FIR filters with the help of suitable equations and application of each of these filters.

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 Write short notes (any two) **(8 x 2)**

- **a)** Impulse invariant method
- **b)** Discrete Cosine Transform
- **c)** Windowing method in FIR filter design
- **d)** Properties of DFT

Q4 **a)** Find the DIT-FFT of $x(n)=\{1,4,16,32\}$. **(8 x 2)**

b) Convert the analog IIR filter into the digital IIR using impulse invariant method for given transfer function $H(S)=\frac{(S+0.9)}{(S+0.9)^2+81}$.

Q5 The output of an impulse response is given by, $H(z)=\frac{16z(z^2-8)}{15z^3-5z^2+3z-5}$, write the equation and then draw the block diagram of: **(16)**

- **a)** Direct-form-I
- **b)** Direct form-II
- **c)** Cascade Direct Form-I

Q6 **a)** For an analog system response $H(S)=\frac{b}{S+a}$ prove that $H(Z)=\frac{b}{\frac{2}{T}\left(\frac{1-Z^{-1}}{1+Z^{-1}}\right)+a}$. **(8)**

b) If $S=\delta+j\Omega$ and $Z=re^{j\omega}$ (where Ω is analog frequency and ω is digital frequency) then prove that $\delta=\frac{2(r^2-1)}{T(r^2+1+2r\cos\omega)}$. **(8)**