BRAINWARE UNIVERSITY

Term End Examination 2024-2025
Programme – M.Tech.(RA)-2024
Course Name – Signal Processing in Mechatronic System
Course Code - MEC10301A
(Semester I)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) The discrete time function defined as u(n)=n for n≥0 and u(n)=0 for n<0 is represented as:

a) Unit sample signal
b) Unit step signal
c) Unit ramp signal
d) None of the mentioned

(ii) An analog signal is represented as x(t) = 10cos(200*pi*t). If sampling frequency is 150Hz, calculate an alias frequency corresponding to sampling frequency = 150Hz.

a) 200Hz
b) 100Hz
c) 10Hz
d) 50Hz

(iii) Identify Z-transform of the convolution of two signals, x[n] and h[n].

a) X(Z)H(Z)
b) X(Z) * H(Z).
c) X(Z)H(Z) + 1
d) X(Z)H(Z) - 1

(iv) With respect to time, the Impulse function is expressed as the derivative of-

a) sinusoidal function
b) exponential function
c) ramp function
d) step function

(v) If X(z) has a single pole on the unit circle , on negative real axis then, x(n) is expressed as-

a) signed constant sequence
b) signed decaying sequence
c) signed growing sequence
d) constant sequence

(vi) Identify the correct condition if a signal is folded about the origin in time then-

a) magnitude spectrum undergoes change in sign
b) phase spectrum undergoes change in sign
c) magnitude remains unchanged
d) magnitude remains unchanged and phase spectrum undergoes change in sign

(vii) If X(k) consists of N-number of frequency samples , then its discrete frequency is expressed as -

a) kfs/N
b) fs/N
c) kN/fs
d) N

(viii) Identify the role of the Fast Fourier Transform (FFT) in signal processing-

a) convert continuous signals into digital form.
b) perform high-pass filtering on digital signals.
c) efficiently compute the Discrete Fourier Transform (DFT) of a digital signal
d) encode digital signals for transmission

(ix) Calculate z-transform X(z) of the signal x(n)={1,2,5,7}?

a) 1+2z^(-1) + 5z^(-2) + 7z^(-3)
b) 1+2z^(1) + 5z^(2) + 7z^(3)
c) 7+5z^(-1) + 2z^(-2) + 2z^(-3)
d) 7+5z^(1) + 2z^(2) + 2z^(3)

(x) In an N-point sequence, if N=16, then calculate the total number of complex additions and multiplications using Radix-2 FFT-

a) 64 and 80
b) 80 and 64
c) 64 and 32
d) 24 and 12

(xi) The width of the main-lobe in rectangular window spectrum is chosen as ,

a) 4*pi/N
b) 16*pi/N
c) 8*pi/N
d) 2*pi/N

(xii) The symmetric impulse response having even number of samples cannot be used to develop-

a) lowpass filter
b) bandstop filter
c) highpass filter
d) bandpass filter

(xiii) Choose the main advantage of the Fast Fourier Transform (FFT) algorithm over the direct computation of the Discrete Fourier Transform (DFT)-

a) FFT can handle continuous signals.
b) FFT requires less memory.
c) FFT is more accurate
d) FFT is much faster for large input sizes.

(xiv) In radar signal processing, select from the following how is the Doppler effect applied to detect the speed of moving objects?

a) By analyzing the time delay of received signals
b) By measuring the frequency shift of reflected signals
c) By comparing signal amplitudes
d) By assessing signal polarization

(xv) Choose a medical imaging technique that is commonly used to detect bone fractures and dental problems-

a) Ultrasound
b) X-ray
c) CT scan
d) PET scan

Group-B

(Short Answer Type Questions) 3 x 5=15

2. Explain Blackman window. (3)

3. Explain the role of DSP in SPECT (Single Photon Emission Computed Tomography) scan in medical applications. (3)

4. Describe energy and power signal relating to discrete time signal. (3)

5. Evaluate z-transform and ROC of the sequence (3)

$$x(n)=\left\{1,\underset{\uparrow}{0},3,-1,2\right\}.$$

6. Explain and proof multiplication property of z-transform. (3)

OR

Explain and proof time shifting property of z-transform. (3)

Group-C
(Long Answer Type Questions) 5 x 6=30

7. Illustrate whether the system described by the following input output equation is linear or nonlinear: (5)
$y(n) = nx(n)$

8. Calculate the z transform and ROC of the given signal: (5)
$x(n) = a^n u(n) + b^n u(-n-1)$

9. Identify the transfer function and impulse response of the system described by the difference equation through z-transform (5)
y(n)-3y(n-1)-4y(n-2)=x(n) 2x(n-1).

10. Explain the role of DSP in X-ray in medical applications. (5)

11. Explain the procedure for design of low pass digital butterworth filter. (5)

12. Determine whether the following signal is periodic or aperiodic? If periodic signal, then calculate fundamental period. (5)
$x(n) = \cos\left(\frac{5\pi}{9}n + 1\right)$

OR

Determine the response of an LTI system whose input x(n) and impulse response h(n) are given by (5)
$x(n) = \{1, \underset{\uparrow}{2}, 0.5, 1\}, h(n) = \{1, \underset{\uparrow}{2}, 1, -1\}$.