CS/B.TECH(BME)/SEM-6/BME-602/2012

2012
BIOMEDICAL SIGNAL PROCESSING

Time Allotted : 3 Hours   *Full Marks :* 70

The figures in the margin indicate full marks.

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

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

                                            10 × 1 = 10

    i)   *Z* transform of a time domain signal helps in predicting................ of the system through which the signal is passing.

         a)   convergency   b)   divergency

         c)   stability   d)   accuracy.

    ii) The angle of the poles with respect to the *+ve* real axis of *z*-plane provides .... of the sinusoidal signal.

         a)   amplitude   b)   phase

         c)   frequency   d)   PSD.
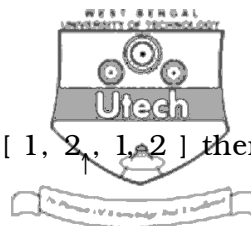
iii) If $x(n) = [3_\uparrow, 2, 1, 2]$ and $h(n) = [1, 2_\uparrow, 1, 2]$ then

$y(n) = x(n)^* \, h(n)$ will be

a) $[3, 8_\uparrow, 8, 13, 9, 9, 4]$ b) $[3, 8_\uparrow, 8, 12, 9, 4, 4]$

c) $[3_\uparrow, 8, 8, 12, 9, 4, 4]$ d) $[3, 8, 8, 13_\uparrow, 9, 9, 4]$

iv) Z-transform of step function $u(n)$ is

a) $1/(z + 1)$

b) $1/(z - 1)$

c) $z/(z + 1)$

d) $z/(z - 1)$.

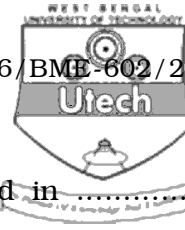v) DFT of each point needs .... complex multiplications and .... complex additions.

a) $N + 1$ and N

b) N and $N - 1$

c) N^2 and $N(N - 1)$

d) $N - 1$ and N^2.

vi) Which of the following systems is non-causal ?

a) $y(n) = 2x(n + 1)$

b) $y(n) = 3x(n) + 5x(n - 1)$

c) $y(n) = x(n)$

d) $y(n) = 4x(n) + 3x(n - 1) + 99x(n - 2)$.

vii) If $X(Z) = Z\{x(n)\}$, then $Z\{a^n x(n)\} = ?$; where a^n = exponential function.

a) $X(a\,z)$

b) $X(a^{-1}z)$

c) $X(a\,z^{-1})$

d) $X(a^{-1}z^{-1})$.

viii) Poles in the LHS of s-plane are plotted in .... of z-plane.

    a)   Inside the unit circle   b)   On the unit circle

    c)   Outside the unit circle   d)   None of these.

ix)   A Signal is an Energy signal if

    a)   Power is 0, Energy is 0

    b)   Power is 0, Energy is non-zero finite

    c)   Power is non-zero finite, Energy is ∞

    d)   Power is ∞, Energy is ∞.

x)   The impulse response of FIR filters are computed for

    a)   finite number of samples

    b)   infinite number of samples

    c)   depending on the values of $H(z)$
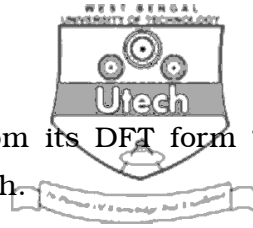
    d)   both (a) and (c).

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2.   Find the Convolution Integral of the following two signals :

$x_1(t) = \cos \pi t \,[u\,(\,t + 1) - u\,(t - 3)\,]$, $x_2(t) = u(t)$

3. How can you obtain a periodic signal from its DFT form ? Explain with proper mathematical approach.

4. Find out the Z-transform and ROC of the following :

$x(n) = a^n u(n) + b^n u(-n - 1)$, where $b < a$

5. Find the DIF-FFT of the following data sequence :

$x(n) = \{ 1, 2, 3, 4, 5, 6, 7, 8 \}$

6. Determine he Direct Form II of the following system :

$y(n) + 2y(n - 1) + 3y(n - 2) = 3x(n) + 5x(n - 1) + x(n - 2)$

7. Determine order and the poles of a type I Low Pass Chebyshev filter that has a 1 dB ripple in the pass band, a cut-off frequency $\Omega_P = 1000\Pi$, a stop band frequency of 2000Π, and an attenuation of 40 dB or more for $\Omega \geq \Omega_S$.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

8. Find the complete solution of the following difference equation :

$y(n) - 3/4y(n - 1) + 1/8y(n - 2) = 2\sin(n\pi/2)$, where

$y(-1) = 2$, $y(-2) = 4$.

Find the IDFT of $X(K) = \{ 3, 2 + j, 1, 2 - j \}$ $9 + 6$

9. a) 2 Poles of a function of LT1 system are on the ROC at 2 points P1 and P2 making angle ω_0 with the positive real axis in z-plane at both 1st and 4th quadrant respectively, of a unit circle of radius r. 2 zeros are located at origin and at the point of intersection 2 poles are making with the positive real axis. Obtain the corresponding time domain signal. 5

b) Determine the z-transform of the signal

$x(n) = [3\,(2^n)\ -4(3^n)\,]\,u(n)$ 4

c) Determine the inverse z-transform of

$$X(z) = \frac{1}{1 - 1\cdot 5z^{-1} + 0\cdot 5z^{-2}}$$

when (i) $ROC\ :\ \left| z \right| > 1,$

(ii) $ROC\ :\ \left| Z \right| < 0\cdot 5$ 6

10. Find out the Inverse Z-transform of

$X(Z) = z\,(z^2 - 4z + 5\,)/\{\,z - 1\,)\,(\,z - 2\,)\,(\,z - 3\,)\,\}$ for the following conditions

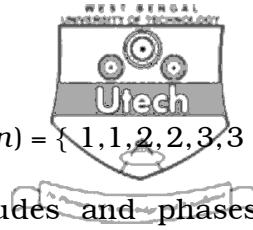a) $2 < \left| z \right| < 3$

b) $\left| z \right| < 1$

c) $\left| z \right| > 3.$

Compute the convolution of the following two sequences :

$x(n) = \{1,\ 1,\ 0_\uparrow,\ 1,\ 0,1\};\ h(n) = \{1,\ 2,\ 1,\ 1_\uparrow,\ 2,\ 1\}$ 9 + 6

11. Derive the *DFT* of the data sequence $x(n) = \{1,1,2,2,3,3\}$ and compute the corresponding amplitudes and phases. Describe the butterfly structure using 8-oint *FFT*.   8 + 7

12. a) A system is defined by the following difference equation

$$y(n) - 2ky(n-1) + k^2 y(n-2) = x(n)$$

    (i)   Determine the range of parameter k for which the system is stable.

    (ii)   Determine the transfer function $h(n)$ of the system.

    (iii)   Draw the *ROC*.   6

   b) Convert the analog filter with system function

$$H_a(s) = \frac{s + 0 \cdot 2}{(s + 0 \cdot 2)^2 + 9}$$

into a digital IIR filter by means of the bilinear transformation. The digital filter have $T = 0 \cdot 1$.   5

   c) Determine the order and poles of a LP Butterworth filter that has a – 3 dB BW of 5000 Hz and an attenuation of 40 dB at 1000 Hz.   4

13. Write short note on any *three* of the following :   3 × 5

      a)   Short Time Fourier Transform (STFT) and Wavelet

      b)   Sampling Theorem and Aliasing Effect

      c)   Radix – 2 Transform

      d)   Proof of the Associative property with a block diagram

      e)   Recursive and Non-Recursive Filters

      f)   Significance of Fast Fourier Transform (FFT).