Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M.Tech (ECE-VLSI)/SEM-2/MVLSI-202/2013

2013
DIGITAL SIGNAL PROCESSING & APPLICATIONS

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.

Answer Question No. 1 and any *four* from the rest.

1. a) State Dirichlet's condition.

   b) Briefly explain the relation between *z*-transform and Laplace transform.

   c) Briefly explain the relation between *z*-transform and DTFT.

   Justify the following sentences :

   d) A discrete LTI system is stable causal if and only if the ROC of the transfer function $H(z)$ includes the unit circle.

   e) A discrete LTI system will be causal if and only if the ROC is the exterior of a circle outside the outermost pole.

   f) Delta function is a frequency independent function.

   g) If the ROC of a *Z*-transform includes the unit circle, the Discrete Time Fourier Transform shall also exist. But reverse statement is not true. 7×2

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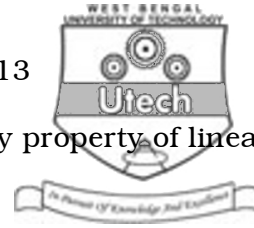
2. a) Show that convolution sum is the only property of linear system.

   Also show that

   i) if system is LTI then output is
   $$y(n) = \sum_{k = -\infty}^{k = \infty} x(k)\, h(n - k)$$

   ii) if the system is linear time varying system then output is $y(n) = \sum_{k = -\infty}^{k = \infty} x(k)\, h(n, k)$

   where $x(n)$ = input sequence, $h(n)$ = impulse response of the system.

   b) Find the inverse z-transform of
   $$X(z) = z/\left(3z^2 - 4z + 1\right) \text{ for } |z| > 1.$$

   c) Find the Z-transform of $x(n) = n\, a^n\, u(n)$.

   d) Find the convolution sum of the following sequences
   $x(n) = \{4, -3, 2\}, \ h(n) = \{-1, 2, 2\}$ using graphical method.

3. a) Prove that the angular frequency of a discrete time signal is bounded within $-\pi$ to π.

   b) What are the differences between DFT and DTFT ?

   c) Find out the IDFT of $Y(k) = \{4, 0, 4, 0\}$.

d) What is the difference between linear convolution and circular convolution ?

e) Obtain the linear convolution of the following sequences $x(n) = \{2, -1, 2\}$, $h(n) = \{1, -1, 2\}$ using circular convolution.   2 + 1 + 5 + 1 + 5

4. a) Determine $H(z)$ from $H(s) = 2/(s^2 + 3s + 2)$ using bilinear transformation if

   i) $T = 1$ sec

   ii) $T = 0 \cdot 1$ sec.

   b) Write *two* advantages and disadvantages of bilinear transformation.

   c) Determine the z-transform, the region of convergence, and the Fourier Transform of the following signal $x(n) = n \cdot a^n \, u(n)$.   6 + 2 + 6

5. a) Obtain the direct form I and II realization for the system described by the following difference equation :

   $y(n) - 0 \cdot 75 \, y(n-1) + 0 \cdot 125 \, y(n-2) = x(n) + 0 \cdot 5x(n-1)$

   b) Find the n-point DFT of the following sequence :

   $h(n) = 1/3$ for $0 \le n \le 2$

   $\qquad = 0 \quad$ otherwise   9 + 5
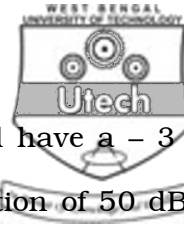
6. a) Design a low-pass digital filter that will have a – 3 dB cut-off at 30 π rad/sec and an attenuation of 50 dB at 45 rad/sec. The filter is required to have a linear phase and the system uses a sampling rate of 100 samples/sec.

b) Explain and distinguish clearly between FIR and IIR filters and show which filter has linear phase characteristics. 9 + 5

7. a) What is multirate signal processing and why is it necessary in digital signal processing ?

b) Distinguish between interpolation and decimation and analyze the rate converter with a rational factor of 1/D. Hence discuss the role of low-pass filter on multirate signal conversion. 4 + 10