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CS/B.Tech(EE-OLD)/SEM-6/EC-611/2013 2013

DIGITAL SIGNAL PROCESSING

Time Allotted: 3 Hours Full Marks: 70

The figures in the margin indicate full marks.

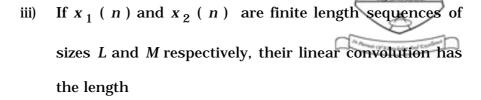
Candidates are required to give their answers in their own words as far as practicable.

GROUP - A

(Multiple Choice Type Questions)

- 1. Choose the correct alternatives for any ten of the following : $10 \times 1 = 10$
 - i) If $x^*(n)$ is the complex conjugate of x(n) then
 - a) $|x(n)|^2 \neq |x^*(n)|^2$
 - b) $| x(n) | = x(n).x^*(n)$
 - c) $|x(n)|^2 = x(n).x^*(n)$
 - d) none of these.
 - ii) On digital differentiation of unit ramp sequence $U_{\,r}\,(\,n\,),$ one obtains
 - a) unit impulse sequence
 - b) unit ramp sequence
 - c) unit step sequence
 - d) none of these.

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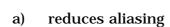
- a) L + M 2
- b) L + M 1

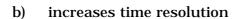
c) L + M

- d) $\max\{L, M\}$.
- iv) If x(n) is a complex sequence, then
 - a) each sample value of x (n) is complex
 - b) some sample values of x(n) must be complex
 - c) at least one sample value should be complex
 - d) no sample value has real component.
- v) Zero padding indicates
 - a) zero appearing in x(k) sequence
 - b) value of x(k) is zero
 - c) dummy samples added with zero value in x(k)
 - d) none of these.



vi) Zero padding a signal





- c) increases frequency resolution
- d) has no effect.
- vii) If X (k) is Z transform of x (n), then Z transform of x (n-k) is

a)
$$Z^k X(k)$$

b)
$$Z^{-k} X(k)$$

c)
$$Z^{1/k} X(k)$$

d)
$$Z^{-1/k} X(k)$$
.

viii) The z-transform of δ (n) is

a)
$$\frac{1}{(1-z^{-1})}$$

b)
$$\frac{1}{z}$$

c) 0

d) 1.

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- ix) The z-transform of u(-n) is
 - a) $\frac{1}{(1-z^{-1})}$
- b) $\frac{z}{(1-z)}$
- c) $\frac{1}{(1-z)}$
- d) $\frac{1}{(z-1)}$.
- x) If $x [n] = \{1, 0, 0, 1\}$, the DFT value of X(0) is
 - a) 2

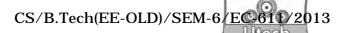
b) 1 + j

c) 0

- d) 1 j.
- xi) Overlap save method is used to find
 - a) circular convolution
- b) linear convolution

c) DFT

- d) Z-transform.
- xii) A digital filter is said to be IIR
 - a) if present output depends on previous output only
 - b) if system function $H\left(\right. z\left. \right)$ has one or more non-zero denominator coefficients
 - c) if all the poles lie outside the unit circle
 - d) if system function has only zeros.



GROUP - B

(**Short Answer Type Questions**) Answer any *three* of the following.



- 2. State Parseval's energy theorem.
- 3. Define convolution sum. a)
 - b) Determine whether the following signal is energy or power or neither energy nor power singal:

$$x(n) = e^{f(\frac{\pi n}{4} + \frac{\pi}{5})}$$
 2 + 3

- 4. Find out the DFT of $x(n) = \{2, 1, 2, 1\}$
 - Determine the Fourier transform of the signal: b)

$$x(n) = 3^n u(-n) - 3^{-n} u(n)$$

- 5. Explain the relationship between S-plane and Z-plane.
- Convert the single pole low-pass IIR filter with system function $H(Z) = \frac{0.5(1+z^{-1})}{1-0.302Z^{-1}}$ into band-pass filter with 6. upper and lower cut-off frequencies ω_u and ω_I respectively. The low-pass filter has 3 dB band width, $\omega_u = 3\Pi/4$, $ω_l = Π/4$, $ω_p = Π/6$. $ω_p$ is the pass-band frequency.

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GROUP - C (Long Answer Type Questions)

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

7. a) Find the system function and impulse response of the system described by the difference equation

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

b) Find the inverse z-transform of

$$X(z) = \frac{0.2 + z}{(0.5 + z)(z - 1)}, |z| > 1$$

- c) What is zero padding? What is its use? 5 + 5 + 5
- 8. a) Compute the DFT of a sequence $(-1)^n$ for N = 3.
 - b) Explain the decimation in time FFT algorithm. 7
 - c) Find the order of the Butterworth filter that has a
 2dB passband attenuation at a frequency of
 20 rad/sec and 10dB stop band attenuation at
 30 rad/sec.
- 9. a) Find the DFT of the sequence { 1, 1, 1, 1, 2, 2, 2, 2 } using radix-2 decimation-in-time FFT. Sketch the magnitude and phase plot.
 - b) What is the need of FFT?
 - c) What is bit-reversal?
- 10. a) Using Bilinear transformation, design a high-pass filter monotonic in pass-band with a cut-off frequency of 1 kHz and down by 10 dB at 350 Hz while sampling frequency is 5 kHz.

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- b) Determine the Z-transform of the following singals and indicate their ROC along with pole zero plots:
 - i) $x(n) = (a^n \cos \omega_0 n) u(n)$
 - ii) $x(n) = a^n u(n) + b^n u(-n-1), |a| < |b|.$ 4 + 4
- 11. Find the Z-transform and the region of convergence of the singal:
 - a) $x(n) = -b^n U(-n-1)$ 5
 - b) $x(n) = \left(\frac{1}{3}\right)^{n-1} u(n-1)$
 - c) Obtain the structure of cascade and parallel realization of the following transfer function :

$$H(z) = \frac{(1-z^{-1})^3}{(1-\frac{1}{8}z^{-1})(1-\frac{1}{2}z^{-1})}$$

- 12. Write short notes on any *three* of the following : 3×5
 - a) Circular convolution
 - b) Utility of FFT over DFT
 - c) BIBO stability in Z domain
 - d) Gibbs Phenomenon
 - e) Periodic and aperiodic signal
 - f) Chebyshev filter
 - g) Causal and non-causal system
 - h) Radix-2 DIF algorithm
 - i) Bilinear transformation.