Name : .....

Roll No. : .....

Invigilator's Signature : .....

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.

iii) If $x_1(n)$ and $x_2(n)$ are finite length sequences of sizes L and M respectively, their linear convolution has the length

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

a) reduces aliasing

b) increases time resolution

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 $\delta(n)$ is

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

c) 0 d) 1.

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 $H(z)$ 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. 3 × 5 = 15

2. State Parseval's energy theorem.

3. a) Define convolution sum.

   b) Determine whether the following signal is energy or power or neither energy nor power singal :

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

2 + 3

4. a) Find out the DFT of $x(n) = \{2, 1, 2, 1\}$

   b) Determine the Fourier transform of the signal :

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

5. Explain the relationship between S-plane and Z-plane.

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

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. 3 × 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

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

c) What is zero padding ? What is its use ? 5 + 5 + 5

8. a) Compute the DFT of a sequence $(-1)^n$ for $N = 3$. 4

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. 4

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. 5

b) What is the need of FFT ? 5

c) What is bit-reversal ? 5

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. 7

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) $x(n) = \left(\frac{1}{3}\right)^{n-1} u(n-1)$ 5

c) Obtain the structure of cascade and parallel realization of the following transfer function :

$$H(z) = \frac{(1 - z^{-1})^3}{(1 - \frac{1}{8} z^{-1})(1 - \frac{1}{2} z^{-1})}$$ 5

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.