Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(EE)/SEM-6/EC-611/2012

2012

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) The digital system is $y(n) = x(n^2)$ is

a) linear and causal

b) non-linear and causal

c) linear and non-causal

d) non-linear and non-causal.

ii) Zero padding of a signal

a) reduces aliasing

b) increases frequency

c) increases time resolution

d) has no effect.

iii) The convolution of $u(n)$ with $u(n-4)$ at $n = 5$ is

a) 5 b) 2

c) 1 d) 0.

iv) Stability criteria for discrete time LTI system is

a) $h(n) > 1$ b) $h(n) < 1$

c) $h(n) = 0$ d) $h(n) = 1$.

v) $\left(\frac{1}{2}\right)^n u(n)$ is

a) energy signal b) power signal

c) both (a) and (b) d) none of these.

vi) Which one of the following is not used for IIR system realization ?

a) direct form structure

b) linear phase structure

c) cascade form structure

d) parallel from structure.

vii) I. In DIF FET algorithm input is normal order and output is bit reversed

II. Both DIT and DIF algorithms require same number of operation to compute DFT

III. In DIF algorithm (in butterfly diagram) the complex multiplication takes place after add-substract operation.

Here

a) only I is true b) I and II are true

c) I and III are true d) I, II and III are true.

viii) For a 32 point sequence, radix 2 FFT algorithm involves

a) 160 complex additions and 160 complex multiplications

b) 80 complex additions and 80 complex multiplications

c) 160 complex additions and 80 complex multiplications

d) 80 complex additions and 160 complex multiplications.

ix) I. In overlap add method longer sequences are divided into smaller sequences

II. In overlap save method each section of the longer sequences are converted to size of the output sequence of sectional convolution

III. For both overlap add and overlap save methods circular convolution can be used.

Here

a) I and II are correct

b) I and III are correct

c) II and III are correct

d) None of these.

x) The ROC of the *z*-transform causal sequence is

a) the interior of circle b) the exterior of circle

c) a rectangle d) an annular region.

xi) For rectangular window used for designing FIR filters, the peak amplitude of side lobe is

a) – 41 dB b) – 3 dB

c) 0 dB d) – 13 dB.

xii) The sequence $x(n) = (-1)^n$ is periodic with a period of

a) 6 samples b) 4 samples

c) 2 samples d) 0 sample.

GROUP – B

(Short Answer Type Questions)

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

2. Find out inverse *z*-transform of

$X(z) = \log(1 - 0 \cdot 5z^{-1}); \ |z| > 0 \cdot 5$ using differential property.

3. a) Determine whether the system is (i) causal (ii) stable

i) $h(n) = 2^n u(-n)$

ii) $h(n) = \delta(n) + \sin n\pi$

b) Define discrete fourier series. 3 + 2

4. Determine the convolution of the given sequences by *z*-transform to the input signal

$h(n) = (0 \cdot 5)^n u(n)$

$x(n) = 3^n u(-n)$.

5. If a discrete-time LTI system is BIBO stable, show that the ROC of its system function $H(z)$ must contain the unit circle, i.e. $|z| = 1$.

6. If $x(n) = \{1, 3, 2\}$ and $y(n) = \{1, 2\}$, find the linear convolution $x(n) * y(n)$ using DFT based approach.

GROUP – C

(Long Answer Type Questions)

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

7. a) Find the *z*-transform of the discrete time signal

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

b) Find the inverse *z*-transform of

$$X(z) = \frac{z(z^2 - 4z + 5)}{(z-3)(z-1)(z-2)}$$

for ROC i) $2 < |z| < 3$, ii) $|z| > 3$, iii) $|z| < 1$.

7 + 8

8. a) Prove that the LTI system is BIBO stable if the ROC of the system function includes the unit circle.

b) Find the linear convolution using circular convolution for the two sequences

$x(n) = \{1, 2, -1, 2, 3, -2, -1, 1, 2, -1\}$, $h(n) = \{1, 2\}$

c) Compute the circular convolution of the two sequences

$x(n) = \{1, 2, 0, 1\}$, $x(n) = \{2, 2, 1, 1\}$.

d) Define phase delay and group delay. 3 + 5 + 5 + 2

9. a) Explain impulse invariant method of designing IIR digital filter.

   b) Design and realize a digital LPF using bilinear transformation method to satisfy the following specifications :

      i) Monotonic stop and pass band

      ii) –3dB cutoff frequency at 0·5π

      iii) Magnitude down to at least 15 dB at 0·75π. 5 + 10

10. a) Design an ideal low pass filter with a frequency response

$$H_d(e^{j\omega}) = 1, \text{ for } \frac{\pi}{4} \le |\omega| \le \pi$$

$$= 0, \text{ for } 0 \le |\omega| \frac{\pi}{4}$$

using windowing technique.

   b) What is Gibb's phenomenon ? What are its effect in digital filter and how to reduce it ? 10 + 5

11. a) Determine the direct form-I and direct form-II structures for the given system

$$y(n) = 0 \cdot 5\, y(n-1) - 0 \cdot 25\, y(n-2) + x(n) + x(n-1)$$

b) Determine the *z*-transform of the signal $x(n) = (\cos\ \omega_0 n)u(n)$.

c) State Sampling theorem. What do you mean by Nyquist rate ? 8 + 5 + 1 + 1

12. Write short notes on any *three* of the following : 3 × 5

a) Radix-2 DIF algorithm

b) IIR and FIR filters

c) Mapping of *s*-plane into *z*-plane

d) BIBO stability

e) Causal and non-causal systems

f) TMS320C 6713 architecture.

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