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.

GROUP – A

1. Choose the correct alternatives for any *fourteen* of the following : $14 \times 1 = 14$

   i) Digital signals are

      a) discrete in time and discrete in amplitude

      b) discrete in amplitude and quantized in amplitude

      c) discrete in time and continuous in amplitude

      d) discrete in amplitude and quantized in time.

   ii) $x(n) = (1/3)^n u(n)$ is a

      a) power signal b) energy signal

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

   iii) e^{jwn} is periodic only if

      a) w is multiple of π b) n is multiple of π

      c) w is multiple of 2π d) both (b) & (c).

iv) (1/N) $\sum_{n=<N>} |x(n)|^2 = \sum_{k=<N>} |C_k|^2$ this equation states the

a) Perseval's relation

b) Power of the signal $x(n)$

c) Energy of the signal

d) Both (a) & (b).

v) Sufficient condition for existence of DTFT for an aperiodic sequence $x(n)$ is

a) $\sum_{n=0}^{\infty} |x(n)| < \infty$

b) $\sum_{n=0}^{\infty} |x(n)| > \infty$

c) $\sum_{n=-\infty}^{\infty} |x(n)| < \infty$

d) $\sum_{n=-\infty}^{\infty} |x(n)| > \infty$.

vi) ROC of the $X(z)$ is the

a) set of some values of z for which $X(z)$ attains a finite value

b) the value of z for which only $X(z)$ attains the finite value

c) the value of $X(z)$ for which a finite region can be defined

d) set of all values of z for which $X(z)$ attains a finite value.

vii) Which of the following statement(s) is/are *true* ?

1. ROC can contain pole
2. If $x(n)$ is causal sequence ROC is entire z-plane except $z = 0$
3. ROC of a LTI stable system contains the unit circle.

a) All of these b) Only 2 & 3

c) None of these d) Only 1 & 3.

viii) Frequency response of the system $H(z) = 1/(1 - 3z^{-1})$ is

a) $\left|H\left(e^{jw}\right)\right| = \infty$ & $\angle H\left(e^{jw}\right) = 2\pi n$

b) $\left|H\left(e^{jw}\right)\right| = 1$ & $\angle H\left(e^{jw}\right) = \tan^{-1} 1/(1 - 3\cos w)$

c) $\left|H\left(e^{jw}\right)\right| = 1$ & $\angle H\left(e^{jw}\right) = \tan^{-1} (1 - 3\cos w)$

d) $H\left(e^{jw}\right)$ does not exist.

ix) Two non-intersecting DTLTI system in cascade have impulses $g(n)$ and $h(n)$. The impulse response of the combination is

a) $g(n) \cdot h(n)$ b) $g(n) + h(n)$

c) $g(n) * h(n)$ d) $[g(n) \cdot h(n)]^{-1/2}$.

x) $x(n) = \{1, 0, 0, 1\}$ and $X(k)$ is the DFT of $x(n)$. Now $X(0) =$

a) 2 b) $1 + j$

c) 0 d) $1 - j$.

xi) The transfer function of a system with impulse response $h(n) = u(n) - u(n-1)$ is

a) 2 b) $z/(z-1)$

c) $z/\{(z-1)(z+1)\}$ d) 1.

xii) A DTLTI system with impulse response $g(n)$ is BIBO stable if

a) $\sum_{n=-\infty}^{\infty} |g(n)| < \infty$ b) $\sum_{n=0}^{\infty} |g(n)| < \infty$

c) $\sum_{n=-\infty}^{\infty} |g(n)| < 1$ d) $\sum_{n=0}^{\infty} |g(n)| < 1$.

xiii) z-transform of a causal sequence $x(n)$ is $2/\left[1 - \left(z^{-1}/2\right)\right]$ then $x(0)$ is

a) 1/2 b) 2

c) 1 d) 4.

xiv) If $x(n)$ is a finite duration, two sided sequence, ROC of its z-transform is entire z-plane *except*

a) $z = 0$ b) $z = 1$

c) $z = \infty$ d) both (a) & (c).

xv) The inverse z-transform of $1/(z - z^{-1})$ is

a) $u(n)$ as well as $-u(n-1)$

b) only $u(n)$

c) $u(n)$ as well as $u(-n)$

d) $u(n)$ as well as $u(n-1)$.

xvi) The z-transform of $u(n-1)$ is

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

c) $1/z(1 - z^{-1})$ d) $1 + z^{-1}$.

GROUP – B

Answer any *four* of the following. 4 × 14 = 56

2. What is warping effect ? How can you remove it ?

Design a Butterworth filter for the following specification. Use Bilinear transformation technique.

i) 3 dB attenuation at 1·5 kHz

ii) 10 db attenuation at 3 kHz

iii) Sampling frequency F = 8000 Hz. 5 + 9

3. What is DFT ? Find out 4-pont DFT of x (n), where $x(n) = \{1, 2, 3, 4\}$. Use matrix method.

What is FFT ? Find out 8-point FFT of x (n), where $x(n) = \{0, 1, 2, 3\}$. Use DIT algorithm. 5 + 9

4. Obtain the Direct form I, Direct form II, Cascade & parallel form realization of following system.

$$y(n) = -0{\cdot}1y(n-1) + 0{\cdot}2y(n-2) + 3x(n) + 3{\cdot}6x(n-1) + 0{\cdot}6x(n-2)$$

5. Classify discrete time signals with examples. What is the causality condition for an LTI system ? Determine the following system is

$$y(n) = 3y^2(n-1) - nx(n) + 4x(n+1) - x(n+1)\ n \geq 0$$

i) Static/Dynamic

ii) Causal/Non-causal

iii) Linear/Non-linear

iv) Time invariant/Time variant

v) Stable/Unstable

vi) FIR/IIR. 6 + 2 + 6

6. What is convolution sum ? What are the properties convolution sum follows ? Find out the convolution of the two signals given

$$x(n) = (1/3)^n\ u(-n-1)$$

$$h(n) = u(n-1)$$

Determine the impulse response of the given causal system.

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

1 + 2 + 3 + 8

7. Determine & sketch the magnitude phase reponse of the following signal.

$x(n) = n\ (1/2)^{|n|}$

Determine the system function $H\ (\ z\ )$, impulse response of the given discrete time system described by the difference equation.

$y\ (\ n\ ) - y\ (\ n - 1\ ) + (\ 3/16\ )\ y\ (\ n - 2\ ) = x\ (\ n\ ) - (\ 1/2\ )\ x\ (\ n - 1\ )$

Determine the stability of the system. Plot the pole-zero diagram. 6 + 8