ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2008
DIGITAL SIGNAL PROCESSING
SEMESTER – 6

Time : 3 Hours] [Full Marks : 70

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) 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) $(1+Z^{-1})$.

ii) Considering τ as the sampling period, transfer function of a discrete-time integrator employing trapezoidal integration is

a) $\frac{\tau}{2}\left(\frac{Z+1}{Z-1}\right)$ b) $\frac{\tau}{2}\left(\frac{Z-1}{Z+1}\right)$

c) $\frac{\tau}{1-Z^{-1}}$ d) $\frac{\tau}{2}\left(\frac{1}{Z+1}\right)$.

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

a) 2 b) $\frac{Z}{Z-1}$

c) $\frac{Z}{(Z-1)(Z+1)}$ d) 1.

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

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

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

v) 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 $Z = 0$ and $Z = \infty$. ☐

vi) If $x(n)=\{2, \underset{\uparrow}{4}, 6, 1\}$ then $x(n-2)$ is

a) $\{2, 4, \underset{\uparrow}{6}, 1\}$ b) $\{2, 4, 6, \underset{\uparrow}{1}\}$

c) $\{2, 4, 6, 1, \underset{\uparrow}{0}\}$ d) $\{\underset{\uparrow}{0}, 2, 4, 6, 1\}$. ☐

vii) If $x(n)$ is a sequence of L samples and $h(n)$ of M samples, the convolution of $x(n)$ and $h(n)$ contains

a) Max (L, M) samples b) L + M – 1 samples

c) L + M – 2 samples d) L + M samples. ☐

viii) The inverse Z-transform of $1/(1-Z^{-1})$ is

a) u(n) as well as –u (– n – 1) b) u(n) but not u (– n – 1)

c) u(n) as well as u(–n) d) u(–n) but not u(n). ☐

ix) the Fourier transform of an aperiodic discrete-time sequence is

a) discrete & periodic function of frequency

b) discrete & aperiodic function of frequency

c) continuous & periodic function of frequency

d) continuous & aperiodic function of frequency. ☐

x) Z-transform of a causal sequence $x(n)$ is $2/\left(1-\frac{1}{2}Z^{-1}\right)$. Then $x(0)$ is equal to

a) $\frac{1}{2}$ b) 2

c) 1 d) 4. ☐

xi) For a rectangular window of M samples, width of the main lobe is

a) $2\pi/m$ b) π/m

c) $6\pi/m$ d) $4\pi/m$. ☐

xii) If $x(n) = \{\underset{\uparrow}{1}, 0, 0, 1\}$, the DFT value $X(0)$ is

a) 2 b) 1 + j

c) 0 d) 1 – j. ☐

xiii) Two non-interacting DTLTI systems in cascade have impulse responses $g(n)$ and $h(n)$. The impulse response of the combination is

a) g(n) h(n) b) g(n)+h(n)

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

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Find the inverse Z-transform of $X(Z) = \dfrac{Z^2}{Z^2 - 3Z + 2}$; ROC : $|Z| > 2$.

3. Find the DFT of a sequence $x_n = \{1, 1, 0, 0\}$.

4. A DTLTI system with impulse response $h(n) = \{\underset{\uparrow}{1}, 1, 1\}$ is excited by a sequence $x(n) = \{\underset{\uparrow}{4}, 3, 2, 1\}$. Determine the output $y(n)$ of the system.

5. The output $y(n)$ and the input $x(n)$ of a discrete-time system are related by the equation $y(n) = e^{x(n)}$. Determine whether the system is linear, time-invariant and stable.

6. A signal $x(t) = 3\cos 200\pi t + 2\cos 500\pi t$ is uniformly sampled at a rate 150 samples/second. Determine the frequency information carried by the sampled version of $x(t)$.

GROUP – C

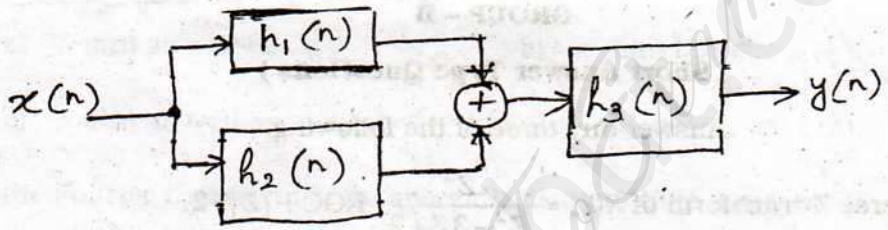
(Long Answer Type Questions)

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

7. a) The output and the input of a recursive DTLTI system are related by the equation $y(n) = -0{\cdot}1y(n-1) + 0{\cdot}2y(n-2) + 3x(n) + 3{\cdot}6x(n-1) + 0{\cdot}6x(n-2)$. Derive and draw the direct form-II structure for realising the system. 5

b) Derive the sketch the cascade and parallel structures for the system with transfer function $H(Z) = \dfrac{2(Z+2)}{(Z-0{\cdot}1)(Z+0{\cdot}5)(Z+0{\cdot}4)}$. 10

8. Determine the impulse response of the system with $x(n)$ as input and $y(n)$ as output shown in figure below. Impulse responses of the subsystems are $h_1(n) = (1/3)^n u(n), h_2(n) = (1/2)^n u_n$ & $h_3(n) = (1/4)^n u_n$. Also determine expression for frequency response of the system. 12 + 3



9. a) Find the IDFT of the sequence $X(K) = \{6,\ -2+j^2,\ -2,\ -2-j^2\}$. 7

b) State the "Sampling Theorem". 3

c) Point out the properties of ROC of Z-transform. 5

10. a) Design a digital Butterworth filter to satisfy the following constraints :

$$0{\cdot}9 \le \left|H(e^{jw})\right| \le 1; \qquad 0 \le w \le \frac{\pi}{2}$$

$$\left|H(e^{jw})\right| \le 0{\cdot}2; \qquad \frac{3\pi}{4} \le w \le \pi$$

Use bilinear transformation. Consider a sampling period of 1 second. 10

b) An analog filter has transfer function

$$G(S)=\frac{2}{(S+1)(S+2)}.$$

Discretize the filter to obtain the transfer function of an equivalent discrete time filter by impulse-invariant technique. Consider a sampling frequency of 2 Hz. 5

11. Write short notes on any *two* of the following : $2\times7\frac{1}{2}$

i) Mapping of *S*-plane into *Z*-plane

ii) DIF algorithm

iii) Design of linear phase FIR filter

iv) Architecture of digital signal processors.

END