WEST BENGAL UNIVERSITY OF TECHNOLOGY

EE-605A

DIGITAL SIGNAL PROCESSING

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
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. Answer any *ten* questions. $10 \times 1 = 10$

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

(A) linear and non-casual (B) linear and casual
(C) non-linear and casual (D) non-linear and non-casual

(ii) For an analog signal = $3\cos 50\pi t + 10\sin 300\pi t$, the Nyquist sampling rate is

(A) 150 Hz (B) 300 Hz (C) 25 Hz (D) 50 Hz

(iii) If ROC of the Z transform of a sequence is outside a circle of radius r. then the sequence is

(A) growing (B) non-casual
(C) decaying (D) casual and decaying

(iv) The Z-transform of $x(n) = \left[\sin\frac{\pi}{2}n\right]u(n)$ is

(A) $\frac{z}{z+1}$ (B) $\frac{z^2}{z^2+1}$ (C) $\frac{1}{z+1}$ (D) $\frac{z}{z^2+1}$

(v) The mapping from analog to digital domain in impulse invariant method is

(A) one to many (B) many to one
(C) one to one (D) none of these

(vi) $e^{2n}u(n)$ is

(A) energy signal (B) power signal
(C) both of these (D) none of these

(vii) If X (K) represents the 8 point DFT of $x(n)=\{1, 1, 1, 1, 1, 1, 0, 0\}$, then X(0) is

(A) 3 (B) 6 (C) 1 (D) 0

(viii) The convolution sum is

(A) $y(n) = x(n) * y(n)$ (B) $y(n) = \sum_{k=-\infty}^{\infty} x(k)\delta(n-k)$

(C) $y(n) = \sum_{k=-\infty}^{\infty} x(k)h(n-k)$ (D) $y(n) = \sum_{k=-\infty}^{\infty} x(k)h(k)$

(ix) A digital filter has $h(n) = \{-3, -2, 0, 2, 3\}$ then it has

(A) no linear phase (B) symmetric linear phase
(C) anti symmetric linear phase (D) none of these

(x) The value of twiddle factor W_8^4 is given by

(A) 1 (B) $-j$ (C) $\frac{1}{\sqrt{2}} - \frac{j}{\sqrt{2}}$ (D) -1

(xi) A digital filter is said to be IIR

(A) if present output depends on previous output only
(B) if satisfy function H(z) has one or more non zero denominator coefficients
(C) if all its poles lie outside the unit circle
(D) if system function has only zeros

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. Find $y(n)$ if $x(n) = n + 2$ for $0 \le n \le 3$
$h(n) = a^n u(n)$ for all n 5

3. When a system is said to be BIBO stable? 5
Find whether the system with impulse response $h(n) = 2e^{-2n}$ is stable or not.

4. Find the DFT of a sequence $x(n)=\{1, 1, 0, 0\}$ 5

5. What is wrapping effect? How can you remove this effect? 5

6. Find casual signal $x(n)$ which is having the Z transform 5
as $X(z) = \dfrac{z^3}{(z+1)(z-1)^2}$

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. (a) Compute the response of the system $y(n) = .7y(n-1) - 0.12y(n-2) + x(n-1) + x(n-2)$ to input $x(n) = nu(n)$. Is the System stable? 8+4+3
(b) What is ROC? State its properties.
(c) What is the relation between z-transform and DTFT?

8. (a) Compute the 8-point DFT of the following sequence 10+2+3
$$x(n) = \left\{\frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}, 0, 0, 0, 0\right\}.$$
Use in-place radix-2 decimation in time FFT algorithm.
(b) What is a butterfly regarding FFT?

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(c) What are the difference and similarities between DIT and DIF algorithms?

9. (a) Design the symmetric FIR lowpass filter using rectangular window for which desired frequency response is expressed as 9+6
$$H_d(\omega) = \begin{cases} e^{-j\omega t} & \text{for } |\omega| \le \omega_c \\ 0 & \text{elsewhere.} \end{cases}$$
Where the length of the filter 7 and w_c=1.
(b) Determine $H(z)$ using impulse invariant method at 5 *Hz* sampling frequency from $H(z) = \dfrac{2}{(s+1)(s+2)}$.

10.(a) Draw cascade structures for the system described by the difference equation $y(n) = \dfrac{3}{4}y(n-1) - \dfrac{1}{8}y(n-2) + x(n) + \dfrac{1}{3}x(n-1)$. 5+10
(b) Design a digital Butterworth filter using the following specifications using bilinear transformation method
$0.8 \le H(j\omega) \le 1$ *for* $0 < \omega < 0.2\,pi$
$H(j\omega) \le 0.2$ *for* $0.6\,pi < \omega < pi$.

11. Write short notes on any *three* of the following: 3×5
(a) Energy and power signal
(b) IIR and FIR filter
(c) Overlap save method and overlap add method
(d) Gibbs phenomenon.

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