



Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech/(EE-NEW)/SEM-6/EE-605A/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 :
 $10 \times 1 = 10$

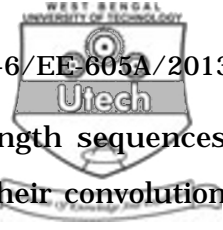
- i) The sampling frequency of the following analog signal

$$x(t) = 3 \sin(150\pi t) + 5 \cos(200\pi t) \text{ should be}$$

- a) greater than or equal to 150 Hz
- b) greater than or equal to 200 Hz
- c) greater than or equal to 600 Hz
- d) less than or equal to 200 Hz.



- ii) The magnitude response $\left| H(e^{j\omega}) \right|$ of digital filter is a
- periodic and odd function of ω
 - periodic and even function of ω
- iii) A discrete-time system is said to be causal if and only if its impulse response $h[n]$ is
- zero for $n < 0$
 - zero for $n > 0$
 - zero at $n = 0$
 - zero at $n \neq 0$.
- iv) Fourier transform of $x[n]$ is $X(\omega)$; then the Fourier transform of $n x[n]$ is
- $-j \frac{dX(\omega)}{d\omega}$
 - $\frac{dX(\omega)}{d\omega}$
 - $j \frac{dX(\omega)}{d\omega}$
 - $\omega \cdot \frac{dX(\omega)}{d\omega}$.
- v) A signal is an energy signal if
- $E < \infty, P = 0$
 - $E < \infty, P = \infty$
 - $P < \infty, E = \infty$
 - $E = \infty, P = 0$.
- vi) The overall impulse response of a cascaded connection of two systems with impulse responses $h_1[n]$ and $h_2[n]$ is
- $h_1[n] + h_2[n]$
 - $h_1[n] \cdot h_2[n]$
 - $h_1[n] * h_2[n]$
 - $h_1[n] - h_2[n]$.



vii) If $x[n]$ and $h[n]$ are two finite length sequences with length 6 and 5 respectively then their convolution has length

- a) 8 b) 9
c) 10 d) 11.

viii) The value of the twiddle factor W_{16}^2 is given by

- a) $0 + j$ b) $0.707 - j 0.707$
c) $0 - j$ d) $-0.707 + j 0.707$.

ix) If $\text{DFT}\{x[n]\} = X(K)$, then for circularly shifted sequence $\text{DFT}\{x(n-2)_N\}$ is

- a) $X(K) e^{-j 4\pi K/N}$ b) $X(K) e^{-j \pi K/N}$
c) $X(K) e^{j 4\pi K/N}$ d) $X(K) e^{j \pi K/N}$.

x) The first three points of a 4-point DFT of a real valued sequence are $\{6, -2 + j 2, -2\}$. The remaining point in the DFT is

- a) $2 - j 2$ b) $2 + j 2$
c) $6 - 2j$ d) $-2 - j 2$.



- xi) An increase in the length of the rectangular window function
- a) increases the main lobe width and computational burden
 - b) increases the main lobe width and decreases computational burden
 - c) decreases the main lobe width and computational burden
 - d) decreases the main lobe width and increase computational burden.
- xii) If $x[n] \leftrightarrow X(z)$ then,
- a) $x[-n] \leftrightarrow X(-z)$
 - b) $x[-n] \leftrightarrow zX(z)$
 - c) $x[-n] \leftrightarrow X(z)/z$
 - d) $x[-n] \leftrightarrow X(1/z)$.
- xiii) The best approximation of a derivative function dx/dt of a continuous system, while discretising is made as
- a) $(x_n - x_{n-1})/T$
 - b) $\frac{x_n + x_{n-1}}{T}$
 - c) $(x_{n+1} - x_n)/T$
 - d) $\frac{x_{n+1} - x_{n-1}}{2T}$.



GROUP - B
(Short Answer Type Questions)

Answer any *three* of the following.

3 × 5 = 15

2. The step response of an LTI system is

$s[n] = \left(\frac{1}{z}\right)^{n-2} u[n-2]$. Find the impulse response of the system.

3. Consider the following two sequences to show how their ROCs are different although their z-transform are same.

$$x_1[n] = a^n u[n].$$

$$x_2[n] = -a^n u[-n-1].$$

4. For the following system determine whether they are linear, causal and time-invariant.

a) $y[n] = e^{x[n]}$

b) $y[n] = x[n] + 3x[n+1].$ $2 \times 2\frac{1}{2}$

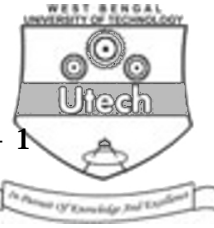
5. Determine the periods of the sequences

a) $x_1[n] = 2 \cos(0.15\pi n) + 5 \sin(0.25\pi n + \pi/3)$

b) $x_2[n] = e^{-j0.2\pi n} + e^{0.7\pi n}.$ $2 \times 2\frac{1}{2}$

6. Obtain a Cascade realisation of the following system :

$$\begin{aligned} y[n] &= 0.8y[n-1] + 0.12y[n-2] \\ &= x[n] + x[n-1] - 2x[n-2]. \end{aligned}$$



7. Given $x[n] = (1 + n/5)$, $-5 \leq n \leq -1$
 $= 1$ $0 \leq n \leq 5$
 $= 0$ otherwise.

- a) Sketch the function $x_1[n] = n x[n]$
 b) Show the even and odd part of $x_1[n]$. $3 + 1 + 1$

GROUP - C

(Long Answer Type Questions)

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

8. a) What do you understand by BIBO stable system ?
 Show that an LTI system is said to be BIBO stable if its impulse response $h[n]$ is absolutely summable

$$i.e., \sum_{n=-\infty}^{\infty} |h[n]| < \infty$$

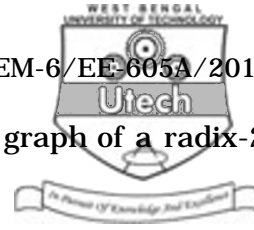
- b) Determine the impulse response of the system given by

$$y[n] = 0.6 y[n-1] - 0.8 y[n-2] + x[n].$$

- c) Use Z-transform to perform convolution of the two sequences

$$x[n] = \delta[n] - \delta[n-2]$$

$$y[n] = 2\delta[n] - 2\delta[n-1] + \delta[n-3] \quad 5 + 5 + 5$$



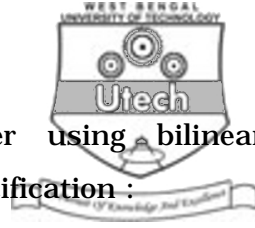
9. a) Show the outputs of a basic butterfly graph of a radix-2 DIF - FFT for inputs x and y .
- b) Find the (outputs) 8 pt DFT of the following sequence using Radix-2 DIF - FFT algorithm after padding with necessary zero.

$$x[n] = \sum_{k=0}^4 (k-2) \delta[n-k].$$

- c) Show how the time complexity of finding the DFT of 256 point data sequence improves by using Radix-2 FFT algorithm instead of using direct computation.
10. a) How is the overlap save method useful in the convolution of sequences ?
- b) Show that time domain convolution is equivalent to Z-domain multiplication of sequences
- c) $x[n] = \{ 2, -1, 3, 4, 1 \}$

$$h[n] = \{ 1, 2, -1 \}.$$

Find $x[n] * h[n]$ using Z-transform.



11. a) Design a Butterworth digital filter using bilinear transformation for the following specification :

$$0.9 \leq \left| H(e^{j\omega}) \right| \leq 1 \quad 0 \leq \omega \leq \frac{\pi}{4}$$

$$\left| H(e^{j\omega}) \right| \leq 0.2 \quad \frac{3\pi}{4} \leq \omega \leq \pi$$

Sampling time $T = 1$ sec.

- b) Discuss how frequency warping effect is taken into account in the design of an IIR filter using bilinear transformation. 10 + 5
12. a) Design a linear phase FIR filter, approximating the ideal frequency response

$$H_d(e^{j\omega}) = e^{-j\omega} \quad \text{for } |\omega| \leq \frac{\pi}{6}$$

$$= 0 \quad \frac{\pi}{6} \leq |\omega| \leq \pi$$

Determine the filter co-efficient for $N = 13$, with a Bartlett window.

- b) Show a realisation of the filter. 12 + 3
13. Write short notes on any *three* of the following : 3 × 5
- Impulse in variant method for design of IIR filter
 - Gibbs phenomenon and its effect
 - Aliasing and sampling rate in signal processing
 - Quantisation and its effect on digital filters.
