DIGITAL SIGNAL PROCESSING (SEMESTER - 6)

CS/B.TECH (ECE-N)/SEM-6/EC-601/09

1. ....
Signature of Invigilator

2. .... **Reg. No.** | | | | | | | | | | | | | | | |
Signature of the Officer-in-Charge

Roll No. of the Candidate | | | | | | | | | | | | | | | |

CS/B.TECH (ECE-N)/SEM-6/EC-601/09

ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2009

DIGITAL SIGNAL PROCESSING (SEMESTER - 6)

Time : 3 Hours] [Full Marks : 70

INSTRUCTIONS TO THE CANDIDATES :

1. This Booklet is a Question-cum-Answer Booklet. The Booklet consists of **32 pages**. The questions of this concerned subject commence from Page No. 3.
2. a) In **Group – A**, Questions are of Multiple Choice type. You have to write the correct choice in the box provided **against each question.**
   b) For **Groups – B** & **C** you have to answer the questions in the space provided marked 'Answer Sheet'. Questions of **Group – B** are Short answer type. Questions of **Group – C** are Long answer type. Write on both sides of the paper.
3. **Fill in your Roll No. in the box** provided as in your Admit Card before answering the questions.
4. Read the instructions given inside carefully before answering.
5. You should not forget to write the corresponding question numbers while answering.
6. Do not write your name or put any special mark in the booklet that may disclose your identity, which will render you liable to disqualification. Any candidate found copying will be subject to Disciplinary Action under the relevant rules.
7. **Use of Mobile Phone and Programmable Calculator is totally prohibited in the examination hall.**
8. You should return the booklet to the invigilator at the end of the examination and should not take any page of this booklet with you outside the examination hall, **which will lead to disqualification**.
9. Rough work, if necessary is to be done in this booklet only and cross it through.

No additional sheets are to be used and no loose paper will be provided

FOR OFFICE USE / EVALUATION ONLY

Marks Obtained

	Group – A										Group – B			Group – C				
Question Number																	***Total Marks***	***Examiner's Signature***
Marks Obtained																		

....
Head-Examiner/Co-Ordinator/Scrutineer

6604 (03/06)

DO NOT WRITE ON THIS PAGE

ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE – 2009

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) If $X_1(n)$ and $X_2(n)$ are finite length sequences of sizes L and M repectively, their linear convolution has length

a) $L + M - 2$ b) $L + M$

c) $L + M - 1$ d) Max $\{ L, M \}$.

ii) A system having impulse response $h(t)$ will be BIBO stable if

a) $\int_{-\infty}^{\infty} |h(t)| \mathrm{d}t < \infty$ b) $\int_{-\infty}^{\infty} h(t) \mathrm{d}t < \infty$

c) $\int_{-\infty}^{\infty} |h(t)| \mathrm{d}t > \infty$ d) $\int_{-\infty}^{\infty} |h(t)| \mathrm{d}t = 0$.

iii) Why 16 point DFT is preferable than 4 point DFT ?

a) Resolution of spectrum is poor for 4 point DFT than 16 point DFT

b) Resolution of spectrum is high but not reliable in 4 point DFT

c) Calculation of 4 point DFT is more complex

d) None of these are true.

iv) Given a system with $h(n) = a^n u(n)$, a is constant, then the system is

a) IIR system b) FIR system

c) both IIR and FIR system d) none of these.

 [redacted]

v) Overlap save method is used to find

a) Circular convolution b) Linear convolution

c) DFT d) Z-transform. [redacted]

vi) If F_{S_i} is the minimum sampling rate, F_{max} is the highest frequency available in the analog signal, then at Nyquist rate

a) $F_{S_i} = 2F_{max}$ b) $F_{S_i} = 0 \cdot 5 F_{max}$

c) $F_{S_i} = F_{max}$ d) $F_{S_i} < F_{max}$. [redacted]

vii) The energy of constant amplitude complex valued exponential function $X(n) = A\exp(j\omega)$ where A and ω are constant, is given by

a) A^2 b) $\dfrac{A^2}{2\omega}$

c) $\dfrac{A^2}{2}$ d) $\dfrac{A^2}{\omega}$. [redacted]

viii) Determine if the systems described by the following input-output equations are causal or non-causal.

1. $y(n) = x(n^2)$

2. $y(n) = \sum_{n=0}^{N-1} x(n)$

a) 1 is linear, 2 is non-linear b) 2 is linear, 1 is non-linear

c) 1 and 2 both are linear d) 1 and 2 both are non-linear. [redacted]

ix) If the Fourier transform of a sequence $x(n)$ is $X(e^{j\omega})$, then the Fourier transform of $x(n-k)$ is

a) 0 b) $(e^{-j\omega k}) \times (e^{j\omega})$

c) $\left(e^{-j\omega}\right) \times (e^{j\omega})$ d) cannot be determined. [redacted]

x) Zero padding indicates

a) zero appending in $X(K)$ sequence

b) value of $X(K)$ is zero

c) Dummy sample added with zero value in $X(K)$

d) none of these.

xi) If $x(n) \overset{z}{\longleftrightarrow} X(z)$, then the valid one is

a) $x(-n) \longleftrightarrow X(z)$

b) $x(-n) \longleftrightarrow z.X(z)$

c) $x(-n) \longleftrightarrow \dfrac{X(z)}{z}$

d) $x(-n) \longleftrightarrow X\left(\dfrac{1}{z}\right)$.

xii) The value of the twiddle factor W_8^4 is given by

a) 1

b) $-j$

c) $\dfrac{1}{\sqrt{2}} - \dfrac{j}{\sqrt{2}}$

d) -1.

xiii) $\left(\dfrac{1}{2}\right)^n u(n)$ is

a) energy signal

b) power signal

c) both of these

d) none of these.

GROUP – B

(Short Answer Type Questions)

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

2. Differentiate between analog and digital signals. Why is digital signal processing widely used than analog signal processing ? 5

3. Determine the convolution of the two following finite sequences using overlap add method : 5

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

4. The impulse response of linear time invariant system is $h(n) = \{ 1, \underset{\uparrow}{2}, 1, -1 \}$. Determine the response of the system to the input signal $x(n) = \{ \underset{\uparrow}{1}, 2, 3, 1 \}$. 5

5. Show that if a discrete-time LPF is described by the difference equation

$y[n] = -\sum_{k=1}^{N} a_k \, y[n-k] + \sum_{k=0}^{M} b_k \, x[n-k]$; then the discrete-time filter described by $y[n] = -\sum_{k=1}^{N} (-1)^k a_k \, y[n-k] + \sum_{k=0}^{M} (-1)^k \, b_k \, x[n-k]$ is a high-pass filter. 5

6. Design a digital Butterworth filter using following specifications using Impulse Invariant method : 5

$0{\cdot}9 < H(j\,\Omega) < 1$ for $0 < \Omega < 0{\cdot}2$ pi $H(j\,\Omega) < 0{\cdot}2$ for $0{\cdot}4$ pi $< \Omega <$ pi.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following questions. 3 × 15 = 45

7. a) A low-pass filter should have the frequency response given below. Find the filter coefficients $h_d(n)$. Also determine τ so that $h_d(n) = h_d(-n)$.

$$H_d(e^{j\omega}) = \begin{cases} e^{-j\omega\tau}, -\omega_c \le \omega \le \omega_c \\ 0, \omega_c < |\omega| < \pi \end{cases}$$ 6

b) A filter is to be designed with the following desired frequency response :

$$H_d(e^{j\omega}) = \begin{cases} 0, -\frac{\pi}{4} \le \omega \le \frac{\pi}{4} \\ e^{-j2\omega}, \frac{\pi}{4} \le \omega \le \pi \end{cases}.$$

Determine the filter coefficients $h_d(n)$ if the window function is defined as

$$w(n) = \begin{cases} 1, 0 \le n \le 4 \\ 0, \text{elsewhere} \end{cases}$$ 9

8. a) Realize the system with difference equation :

$$y(n)=\frac{3}{4}y(n-1)-\frac{1}{8}y(n-2)+x(n)+\frac{1}{3}x(n-1)$$ in cascade form. 8

b) Define LTI system with an example. 5

c) What is window technique ? 2

9. a) What is ROC ? State its properties. 2

b) Find the system function and impulse response of the system described by

$$y(n) = x(n) + 2x(n-1) - 4x(n-2) + x(n-3)$$ 5

c) Find the inverse Z-transform of

$$X(z) = z(z^2 - 4z + 5)/(z-3)(z-2)(z-1) \quad 2 < z < 3.$$ 5

d) Prove that an LTI system is BIBO stable if the ROC system function includes the unit circle. 3

10. a) Distinguish between FIR and IIR filters.

b) What is warping effect ? How can you remove this effect ?

c) Convert the analog filter with the system function $G(s) = \dfrac{s+0\cdot1}{(s+0\cdot1)^2+16}$ into a digital filter using bilinear transformation. The digital filter should have a resonant frequency of $w_r = \dfrac{\pi}{4}$ rad. 15

11. a) Find the DFT of the sequence { 1, 1, 1, 1, 2, 2, 2, 2 } using radix-2 Decimation-in-Time FFT. Sketch the magnitude and phase plot. 10

b) What is the need for FFT ? 3

c) What is bit reversal ? 2

END