

Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/M.Tech (ECE)/SEM-1/ECM-104/2009-10**  
**2009**  
**DIGITAL SIGNAL PROCESSING**

Time Allotted : 3 Hours

Full Marks : 70

*The figures in the margin indicate full marks.*

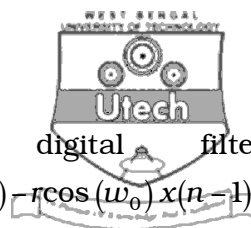
*Candidates are required to give their answers in their own words  
as far as practicable.*

Answer any five questions.

5 × 14 = 70

1. a) Determine 8-point DFT for a continuous time signal  
 $x(t) = \sin(2\pi f t)$  with  $f = 50$  Hz. 8  
  
b) Obtain the linear convolution of two sequences  
 $x(n) = u(n) - u(n-3)$  and  
 $h(n) = u(n-1) + u(n-2) - u(n-4) - u(n-5)$  using circular  
convolution. 6
2. a) What are the various methods used for the design of IIR  
filters ? Discuss impulse invariant method. What is the  
main disadvantage of designing IIR filter using impulse  
invariant method ? How can it be overcome ?

2 + 3 + 2 + 2



- b) Realize the 2nd order digital filter  

$$y(n) = 2r \cos(\omega_0) y(n-1) - r^2 y(n-2) + x(n) - r \cos(\omega_0) x(n-1)$$
 by direct form-I & direct form-II. 5

3. a) A low-pass filter is to be designed with the following desired frequency response

$$H_d(e^{j\omega}) = e^{-2j\omega}, \quad -\Pi/4 \leq |\omega| \leq \Pi/4$$

$$= 0, \quad \Pi/4 < |\omega| \leq \Pi$$

Determine the filter co-efficients  $h_d(n)$  if the window function is rectangular. Also determine the frequency response  $H(e^{j\omega})$  of the designed filter. 8

- b) A low-pass filter should have the frequency response given below. Find the filter co-efficients  $h_d(n)$ . Also determine  $\tau$  so that  $h_d(n) = h_d(-n)$ .

$$H_d(e^{j\omega}) = e^{-j\omega\tau}, \quad -\omega_c \leq \omega \leq \omega_c$$

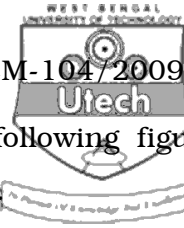
$$= 0, \quad \omega_c < |\omega| \leq \Pi. \quad 6$$

4. a) Write a short note on Zero padding. 4

- b) Derive the algorithm for 16-point DIF-FFT. 10

5. a) What is the need for anti-aliasing filter prior to down sampling? 5

- b) What is the need for anti-imaging filter after up sampling? 5



- c) A multi-rate system is shown in the following figure. Find the relation between  $x(n)$  &  $y(n)$ . 4

6. a) A DSP system is described by the linear difference equation  $y(n) = 0.2x(n) - 0.5x(n-2) + 0.4x(n-3)$ . Given that the digital input sequence  $\{-1, 1, 0, -1\}$  is applied to this DSP system. Determine the corresponding digital output sequence. 5

- b) What do you mean by ROC ? 2

- c) Find  $x(n)$  if

$$X(Z) = 1/[1 - (3/2)Z^{-1} + (1/2)Z^{-2}]$$

For ROC :  $|Z| > 1$  and  $|Z| < 1/2$ . 7

7. a) A discrete time signal  $x(n]$  is applied to a DTLTI system with unit impulse response  $h(n]$ . Find the output response if given that

$$x(n) = 2^n \cdot u(-n) \text{ and}$$

$$h(n) = u(n). \quad 7$$



- b) Write a short note on FIR filter design using Window method. What is Gibb's phenomenon ? 7
8. a) Find the output  $y(n)$  of a filter whose impulse response is  $h(n) = \{1, 1, 1\}$  and input signal  $x(n) = \{3, -1, 0, 1, 3, 2, 0, 1, 2, 1\}$  using Overlap-add method and Overlap-save method. 5 + 5
- b) Compute the DFT of the sequence  $x(n) = (-1)^n$  for  $N = 4$ . 4
9. a) Find the magnitude and phase responses for the system characterized by the differential equation
- $$y(n) = (1/6)x(n) + (1/3)x(n-1) + (1/6)x(n-2). \quad 8$$
- b) Determine the impulse response  $h(n)$  for the system described by the difference equation
- $$y(n) - 3y(n-1) + 4y(n-2) = x(n) + 2x(n-1). \quad 6$$
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