Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.Tech (ECE)/SEM-1/MCE-103/2010-11

2010-11

ADVANCED 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 Question No. 1 and any *four* from the rest.

1. a) What are causal and non-causal systems ? Is the following signal casual/non-casual :

$$x(n) = \{-5,\ 4,\ \underset{\uparrow}{5},\ 3,\ 2,\ 7,\ -9,\ 6\}.$$

b) Define 'shift-invariance'. What is the criteria of the system to possess BIBO stability ?

c) What are meant by periodic and aperiodic signals ? Determine the fundamental period of the D. T. signal :

$$x(n) = \cos\left(\frac{2\pi n}{3}\right).$$

d) Explain why the output of an LTI system cannot contain frequency components not contained in the input signal.

e) What is the significance of Filter Theory in estimation ? What are the different types of estimation in signal processing ?

f) What is the necessity of Mulirate DSP ?

g) Explain the limitations of non-parametric methods of spectrum estimation. 7 × 2 = 14

2. State the Wiener-Khintchine theorem. Derive Parseval's theorem for aperiodic D. T. signals. Evaluate the DTFT $X(w)$ and the Energy Density Spectrum $S_{xx}(w)$ of the D. T. signal :

   $x(n) = a^n\ u(n),\ |a| < 1.$ 3 + 5 + 6

3. State the relationship between Discrete Time Fourier transform and Z-transform. Evaluate the system response to sinusoidal input signals applied at finite time instant $n = 0$. Sketch the pole-zero plot and indicate whether the following systems are minimum/maximum/mixed phase systems :

   $H_1(z) = 6 + z^{-1} - z^{-2}$

   $H_2(z) = 1 - \frac{5}{2}z^{-1} - \frac{3}{2}z^{-2}.$ 4 + 5 + 5

4. What is meant by Radix-2 Fast Fourier transform ? Determine the Four-point DFT of the sequence $x(n) = \{ 1, 2, 1, 2 \}$ and obtain the corresponding magnitude and phase response. Compare between IIR and FIR filters. Explain the basic methodology behind optimization algorithms used for designing Digital Filters. 2 + 5 + 3 + 4

5. What are the characteristics of adaptive filters ? Elucidate briefly how an adaptive system can be configured for system identification. Explain the Least Mean Squares Gradient Approximation method of adaptive filters. 3 + 5 + 6

6. Discuss the basic signal model of the D. T. standard Kalman filter. How is the Kalman filter applicable to Gaussian noise scenarios ? Explain how DFT algorithm is useful in power spectral estimation. 6 + 3 + 5

7. Name a few applications of Multirate DSP ? Explain the time domain and frequency domain characterization of decimator. Analyze the Multirate structure as shown figure and obtain the expression of the output $y(n)$ in terms of $x(n)$. Obtain the polyphase decompositions of the IRR digital system having the following transfer function : $H(z)=\frac{1-4z^{-1}}{1+5z^{-1}}$. 2 + 4 + 4 + 4

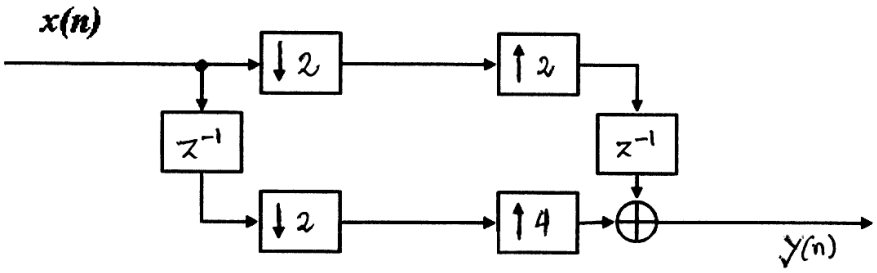

FIG. 1

8. Write short notes on any *two* of the following : 2 × 7

a) Symmetry Properties of D. T. Fourier transform

b) Frequency Sampling Technique in Filter Design

c) Applications of Wavelets Transforms

d) Model-based Power Spectrum Estimation.