Name : ....
Roll No. : ....
Invigilator's Signature : ....

CS/M. Tech (ECE)/SEM-1/MCE-103/2011-12

2011
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.

GROUP – A
(Objective Type Questions)

1. Answer any *ten* of the following questions. $10 \times 1 = 10$

   i) What is the system impulse response if the input and output are $x(n) = (1/2)n\, u(n)$, $y(n) = (1/2)\, n\, u(n)$ respectively ?

   ii) Convert the non-recursive system $H(z) = 1 + z\text{-}1 + z\text{-}2 + z\text{-}3 + z\text{-}4$ into recursive system.

   iii) How the limit cycle oscillations due to overflow are minimized ?

   iv) Determine the direct form realizations for the filter $h(n) = \{1, 2, 3, 4, 3, 2, 1\}$

   v) What are the advantages of multistage implementation in multirate signal processing ?

vi) Where will you place zero & poles in a filter to eliminate 50 Hz frequency in a sampled signal at sampling frequency F = 600 Hz ?

vii) Define sample autocorrelation function. Give the mean value of this estimate.

viii) What is the basic principle of Welch method to estimate power spectrum ?

ix) How do find the ML estimate ?

x) Give the basic principle of Levinson recursion.

xi) What is meant by image smoothing and image sharpening ?

xii) Give the two channel wavelet filter banks to decompose the input signal into frequency bands.

GROUP – B

(Long Answer Type Questions)

Answer any *four* of the following. $4 \times 15 = 60$

2. a) An LTI-DTS is described by the following difference equation. $y(n) - 0{\cdot}6\, y(n-1) + 0{\cdot}25\, y(n-2) = x(n) - 0{\cdot}8 \times (n-1)$; $n \geq 0$; initial rest. Find its complete response when an input $x(n) = 0{\cdot}3 \sin 0{\cdot}3n$ is applied from $n = 0$ onwards by solving the difference equation. Do not use Z transforms.

b) What is meant by BIBO stability of a LTI-DTS system ? Prove that if the impulse response of a LTI-DTS is absolute summable it will be BIBO stable. 10 + 5

3. a) A transfer function given below is implemented in cascade form using 8-bit fixed-point arithmetic. Find out the pole locations of the system in the case of infinite precision system and 8-bit fixed point system that uses truncation.

$$\frac{(z+1)^2}{z^2 + 0\cdot 63z + 0\cdot 72}$$

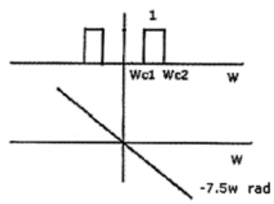
b) The input to a narrow bandpass filter in the discrete domain with centre frequency of $\pi/4$ radians and bandwidth of 0·01 rad is given by $x(n) = 1$ for $0 \le n \le 3$ and 0 for other values of 'n'. Find its approximate output by Fourier Transform techniques. 5 + 10

4. a) Transform a third order Butterworth low pass filter with *DC* Gain of unity and cut-off frequency of 1 rad/sec into discrete domain by impulse invariant transformation using 1 sec sampling and obtain $H(z)$.

b) A LTI-DTS transfer function has poles at 0·3 } j 0·4 and 0·6 } j 0·7. It has zero at z = -1 with multiplicity of four. It has a DC Gain of unity. Draw the signal flow graph in (i) Cascade form and (ii) Parallel form. 5 + 10

5. Design the following low pass filter in the discrete-time domain using Bilinear Transformation. Passband Gain $\geq 0{\cdot}95$, Stopband Gain $\leq 0{\cdot}05$, Passband Edge = 5 kHz, Stopband Edge=15 kHz, Sampling Frequency 50kHz. Monotonic Gain in both passband and stopband is desired. 15

6. Find out the impulse response of a FIR filter designed by Windowing using a Hamming window to approximate the frequency response given on the right side. Wc1 = 1 rad, Wc2 = 2 rad.



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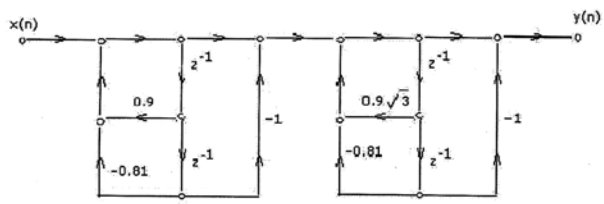
7. Mark the poles and zeros of the system with the signal flow graph given below. (ii) Calculate the steady state gain in magnitude and phase at frequencies $\pi/6$ rad and $\pi/3$ rad using geometric interpretation of frequency response in the z-plane, Show the distance and angle calculations clearly.



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8. Write short notes on any *three* of the following : 3 × 5
   a) Overlap and add method
   b) Bilinear transformation
   c) Radix-2 DIT FFT algorithm
   d) BIBO stability
   e) Linear convolution.