(b) State and prove convolution theorem. 12

7. Determine the inverse Z transform of

$X(z) = 1/(1-1.5z^{-1}+0.5z^{-2})$ 20

If

(a) ROC : $|z|>1$

(b) ROC : $|z|<0.5$

(c) ROC : $0.5<|z|<1$

8. (a) Using convolution theorem find the sequence after convolving the following sequence.

$x_1(n)=x_2(n)=(1,1,1)$

Take second element as reference point. 10

(b) By means of discrete Fourier transform (DFT) and inverse discrete Fourier transform (IDFT), determine the response of the finite impulse response filter (FIR) with impulse response h(n) = {1, 2, 3} to the input sequence x(n) = {1, 2, 2, 1}.

Reference point for both sequence is 1st sample. 10

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Ph.D./Math.Sc/288

Ph.D. Semester II) Examination, 2013-14

Mathematical Science

Paper : MSPR-03

(Digital Signal Processing, Sensor and Systems)

Time : Three Hours ***Full Marks : 100***

(Write your Roll No. at the top immediately on the receipt of this question paper)

Note: Answer any **five** questions and the figures in the right hand margin indicate marks.

1. (a) What do you mean by a signal, signal source and signal processing ? Write advantages of digital over analog signal processing. 8

(b) What is Analog to Digital converter and how it works ? 12

2. (a) Consider the analog signal :

$x(t) = 3 \cos 100 \pi t$

(i) Determine the minimum sampling rate required to avoid aliasing. 3

(ii) Suppose the signal is sampled at the rate F_s = 200Hz, what is the discrete time signal obtained after sampling ? 3

(iii) What is the frequency $0<F< F_s/2$ of a sinusoid that yields samples identical to those obtained in (ii). 4

(b) Consider the analog signal :

$x(t) = 3 \cos 2000 \quad t+5 \sin 6000 \quad t +10 \cos 12000 \quad t$

(i) What is the Nyquist rate for this signal ? 2

(ii) Assume now that we sample this signal using a sampling rate F_s = 5000 samples, what is the discrete-time signal obtained after sampling ? 5

(iii) What is the analog signal y(t) we can reconstruct from the samples if we use ideal interpolation ? 3

3. (a) Discuss the classification of Discrete-Time Systems. Explain each in short. 13

(b) What is the process for computing convolution ? 7

4. (a) Determine the impulse response for the cascade of two linear-time invariant systems having impulse responses. 10

$h_1(n) =$ $(1/2)^n$ $u(n)$ and

$h_2(n) =$ $u(n)$

(b) Determine the zero-input response of the system described by the homogeneous second order difference equation. 10

$y(n)-3y(n-1)-4y(n-2)=0$

5. (a) A linear time invariant system is described by the following equetion :

$y(n)=a\, y(n-1)+b\times(n) \quad 0<a<1$ 12

(i) Determine the magnitude and phase of the frequency response H(w) of the system.

(ii) Choose the parameter 'b' so that the maximum value of $|H(w)|$ is unity.

(b) An LTI system characterized by its impulse response. 8

$h(n) =$ $u(n)$

Determine the spectrum and energy density spectrum of the output signal when the system is excited by the signal.

$x(n) =$ $u(n)$

6. (a) What is Z-transform ? Write its application to the analysis of LTI systems. 8