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M. Tech 3rd Semester Examination

Digital Signal Processing

EC-304

Time : 3 Hours **Max. Marks : 100**

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : (i) All questions carry equal marks.

(ii) Attempt any five questions out of eight questions.

1. (a) Given that the system function of a third order Chebyshev type analogue. Low-pass analogue filter with a 3 dB cut-off frequency of one radian/second is:

$$H(s) = \frac{1}{(1+2s)\,(6+5s+s^2)}$$

use the bilinear transformation to design a third order low-pass digital filter with a 3 dB cut-off frequency at one quarter of the sampling frequency.

(b) Calculate the Convolution of the following sequence for

$a = b$ & $a \neq b$

$x1(n) = (a)^{n-n0}u(n)$

$x2(n) = (b)^{n}u(n-n0)$

$1 > a, b < 1$;

(c) Show that magnitude spectrum is even symmetrical while Phase spectrum is odd symmetrical. (10+5+5=20)

2. (a) Explain all fourier transform properties. Derive the expression of power spectrum density and Energy spectrum density.

(b) Compute the time response of the causal system described by the transfer function

$$H(z) = \frac{(z-1)^2}{z^2 - 0.32z + 0.8}$$

when the input signal is the unit step.

(c) Find the inverse Z-transform by power series method.

(i) $X(Z)=1/(1+4Z^{-1})\,(1+1/8\,Z^{-1})$

(ii) $X(Z)=1/(1-2Z^{-1})$

(iii) $X(Z)= 1/(1-2Z^{-1})\,(1+4Z^{-1})$

(iv) $X(Z)=1/(1-4Z^{-1})(1-2Z^{-1})^2$ (5+5+10=20)

3. (a) Give H(z) for a DSP system with the following difference equation:

$y[n] = x[n] + x[n+4] + 0.4\,y[n+1]$

Determine whether it is causal and stable and sketch its gain-response.

(b) What is the difference between impulse invariance and bilinear transformation technique.

(c) Discuss the frequency sampling method of FIR filter design. Using this method design a filter for h(n)={-2,1,2}. Also indicate the signal flow graph. (6+6+8=20)

4. (a) Consider discrete time linear casual system defined by difference eq.

$Y(n)-3/4\,y(n+1) + 1/8\,Y(n-2) = X(n) + 1/6\,X(n+1)$

Find its system function and realize using DF1 and DF2.

(b) Obtain the Direct form II and cascade realization for the system

$$H(z)=\frac{(z-1)(z^2+5z+6)(z-3)}{(z^2+6z+5)(z^2-6z+8)}$$

(c) State the properties of Z-transform with examples. (5+10+5=20)

5. (a) Design a Butterworth filter for the following specification using bilinear transformation method

Pass band Frequency = 0.2π

Pass band attenuation = 1 dB

Stop band Frequency = 0.3π

Stop band attenuation = 15 dB

Assume T=1

(b) The unit impulse response of a certain IIR analog filter is $h(t)=e^{-2t}\,u(t)-e^{-3t}u(t)$. Determine the system transfer function of the corresponding digital filter. Verify whether filter is stable or not. (10+10=20)

6. (a) Perform the circular convolution of sequence

(i) X1(n) ={–5,4,6,1,2, –1,2}

(ii) X2(n) ={1,0,2,0,3.3,0}

(b) Find 4 pt. 8 pt DFT of following:

X(n)= {1, –4, –2, –1}

(c) If the input signal to a digital filter with frequency response

$H(e^{j\Omega}) = (5 + 2\sin(\Omega))e^{j\Omega/2}$

is {x[n]} with x[n] = 3 sin(0.75 n) for all n, what is the output signal? (8+8+4=20)

7. (a) Write a short note on:

(i) Frequency transformation

(ii) A/D and D/A Converter

(iii) Minimum phased systems

(iv) Digital IIR notch filter

(b) Compute the eight point DFT for the sequence

X(n) = {0,1,2,3,4,5,6,7}

By Using the radix -2 DIF-FFT algorithm (12+8=20)

8. (a) Check the following system for stability, causality and time invariance

(i) y(n)= sin (x(n))

(ii) y(n)=x(n)+x(n–1)

(iii) y(n)=x(n)–x(n–2)–x(n+2)

(iv) $y(n)=x(n^3)$

(v) $y(n)=x(n)^2$

(b) Compare the following:

(i) Butterworth and Chebyshev filter.

(ii) IIR and FIR filter. (10+10=20)