Code : 041810

B.Tech 8th Semester Exam., 2017

Digital Signal Processing

Time : 3 hours *Full Marks : 70*

Instructions :

(i) The marks are indicated in the right-hand margin.

*(ii) There are **EIGHT** questions in this paper.*

*(iii) Attempt **FIVE** questions in all.*

(iv) Questions No. 1 is compulsory.

1. Answer any seven question of the following: 2×7=14

(a) If $x(n)=0$ for $n<N_1$ and $h(n)=0$ for $n<N_2$, then $x(n)*h(n)=0$ for $n<N_1+N_2$; $x(n)*h(n)$ represents the convolution of the sequences $x(n)$ and $h(n)$. TRUE/FALSE

(b) An FIR system will produce a linear phase if its impulse response is either symmetrical or anti-symmetrical. TRUE/FALSE

P.T.O.

(c) If a sequence is even and odd then its DTFT will be purely real. TRUE/FALSE

(d) An IIR filter essentially contains poles and zeros. TRUE/FALSE

(e) If $X(j\omega)$ is the DTFT of $x(n)$, determine the DTFT of $x^*(n)$

(f) The convolution of a finite sequence with an infinite sequence is always an infinite sequence. TRUE/FALSE

(g) If discrete Fourier series coefficients of the periodic signals $x(n)$ and $y(n)$ having the same period N are a_k are b_k respectively. Determine the Fourier series coefficients of the signal $x(n)y(n)$.

(h) Choose the correct answer of the following

A system characterized by the system function $H(z)=\frac{1}{2}(1-z^{-1})$ is a

(i) Low-pass filter

(ii) Band-pass filter

(iii) High-pass filter

(iv) Band-stop filter

(i) From the definition of discrete Fourier transform derive the relation of inverse discrete-Fourier transform.

(j) Let $x(t)$ be a signal with Nyquist rate ω_0. Determine the Nyquist rate of the signal $x(t)\cos(\omega_0 t)$

2. (a) Describe the basic elements of a DSP system. Write the advantages of a DSP systems over ASP systems. 5

(b) Give the classifications of signals. Define Causal, anti-causal and two sided signals with suitable examples. 5

(c) Explain the concept of frequency in continuous time domain and discrete time domain. 4

3. (a) Explain linear time invariant system. Determine whether the system described by input-output relationship $y(n)=Re\{x(n)\}$ is linear or not, where $Re\{x(n)\}$ represents the real part of $x(n)$. 7

(b) Determine the zero-input response of the system described by the homogeneous second-order difference equation $y(n)-3y(n-1)-4y(n-2)=0$ with initial conditions $y(-2)-0; y(-1)=5$. 7

4. (a) Determine the convolution sum of the following signals. 7

$x(n) = 1 \quad -9 \le n \le 7$ $\qquad h(n)=1 \quad -3 \le n \le 10$

$= 0 \; otherwise$ $\qquad = 0 \; otherwise$

(b) Define cross-correlation and autocorrelation of sequences. State and prove the properties of cross-correlation and autocorrelation of sequences. 7

5. (a) A causal discrete-time LTI system is described by $y(n)-\frac{3}{4}y(n-1)+\frac{1}{8}y(n-3)=x(n)$ where $x(n)$ and $y(n)$ are the input and output of the system respectively. 2+2+4

(i) Determine its system functions $H(z)$

(ii) Sketch its pole-zero plot

(iii) Find the impulse response *h(n)* of the system

(b) Determine the inverse *Z*-transform of $X(z)=\dfrac{z^{-1}}{1-1.5z^{-1}+0.5z^{-2}}$; if (i) ROC $|z|>1$; (ii) ROC $|z|<0.5$; (iii) ROC $0.5<|z|<1$. 6

6. (a) Design a linear phase FIR filter using windowing method with the following specification. Desired frequency response $H_d\left(e^{j\omega}\right)=\begin{cases} e^{-je\omega} & ;-\omega_c\le\omega\le\omega_c \\ 0 & ;\omega_c\le|\omega|\le\pi \end{cases}$ and M=7, $\omega_c = 1$ rad/sample.

Use Joulious Von Hann (Hanning) window for your design. 7

(b) Show that, in radix–2 decimation in time FFT algorithm, the required number of complex additions and multiplications are $N\ \log_2 N$ and $\dfrac{N}{2}\log_2 N$ respectively. 7

7. (a) A digital Butterworth filter has to be designed using bilinear transformation. The filter specifications are as follows are as follows. Find the filter order *N* and the cutoff frequency Ω_c. 7 marks

$$0.9\le\left|H\left(e^{j\omega}\right)\right|\le1;\quad 0\le\omega\le0.5\pi$$

$$\left|H\left(e^{j\omega}\right)\right|\le0.2;\quad 0.75\pi\le\omega\le\pi$$

(b) Obtain the direct form-II realization of

$$H(z)=\frac{1+\frac{1}{2}z^{-1}+\frac{1}{3}z^{-2}}{1-1.5z^{-1}+z^{-2}}$$ 7

8. (a) An LTI system with impulse response $h_1(n)=\left(\frac{1}{2}\right)^n u(n)$ is connected in parallel with another causal LTI system with impulse response $h_2(n)$. The resulting parallel interconnection has the frequency response $H\left(e^{j\omega}\right)=\dfrac{-12+5e^{-j\omega}}{12-7e^{-j\omega}+e^{-j2\omega}}$. Determine $h_2(n)$. 6

(b) Let $x(n), 0\le n\le N-1$, be an even length sequence with N-point DFT X(k), $0\le k\le N-1$. Determine the N-point DFT's of the following N-point sequence in terms of X(k). 8

(i) $g(n) = x(n) - X\left(n - \frac{n}{2}\right)$

(ii) $y(n) = (-1)^n x(n)$

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