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Roll No.

328651(28)

BE (6^{th} Semester)
Examination, April - May, 2017

[New Scheme]

Digital Signal Processing

Time Allowed : 3 hours *Maximum Marks :* 80

Minimum Pass Marks : 28

Note : (*i*) Part (*a*) of each question is compulsory. Attempt any **two** parts from (*b*), (*c*) and (*d*) of each question.

(*ii*) Assume suitable data wherever necessary.

(*iii*) The figures in the right-hand margin indicate marks.

1. (*a*) Differentiate between DTFT and DFT. [2]

(*b*) Find the DTFT of the following finite duration sequence of length L : [7]

$$x(n) = \begin{cases} A, & \text{for } 0 \le n \le L-1 \\ 0, & \text{otherwise} \end{cases}$$

Also find the inverse DTFT to verify $x(n)$ for L=3 and A=IV.

(*c*) Obtain DFT of the following sequence :

$$x(n) = \{½, ½, ½, ½, 0, 0, 0, 0\}$$

using decimation in frequency FFT algorithm. [7]

(*d*) Let $x(n)$ be a finite duration sequence of length 8 such that

$$x(n) = (-1, 0, 2, 0, -4, 0, 2, 0)$$

(*i*) Find $X(k)$, using DIT FFT flow graph.

(*ii*) Using the result in (*i*) and not otherwise, find DFT of sequence $x_1(n) = \{-1, 2, -4, 2\}$ [7]

2. (*a*) What are the different types of structures for realization of IIR systems? [2]

(*b*) Draw the structures of cascade and parallel realization of [7]

$$H(z) = \frac{\left(1 - z^{-1}\right)^3}{\left(1 - \frac{1}{2}z^{-1}\right)\left(1 - \frac{1}{8}z^{-1}\right)}$$

(*c*) Determine the direct form-II and transposed direct form-II for the given system : [7]

$$y(n) = \frac{1}{2}y(n-1) - \frac{1}{4}y(n-2) + x(n) + x(n-1)$$

(*d*) Realize the following system function, using minimum no. of multipliers :

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

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

3. (a) What is the principle of designing of FIR filter, using window technique? [2]

(b) Design an ideal high-pass filter with frequency response

$$H_d(e^{j\omega}) = 1 \text{ for } \frac{\pi}{4} \le |\omega| \le \pi$$
$$= 0 \text{ for } |\omega| \le \frac{\pi}{4}$$

using Hamming window with N=11. [7]

(c) Design a filter with

$$H_d(e^{j\omega}) = e^{-j3\omega} \quad -\frac{\pi}{4} \le \omega \le \frac{\pi}{4}$$
$$= 0 \quad \frac{\pi}{4} < |\omega| \le \pi$$

using Hamming window with N=7. [7]

(d) Design an ideal Hilbert transformer having frequency response

$$H(e^{j\omega}) = j \quad \text{for} \quad -\pi \le \omega \le 0$$
$$= -j \text{ for } \quad 0 \le \omega \le \pi$$

using rectangular window with N=11. [7]

4. (a) What is bilinear transformation technique? [2]

(b) Determine $H(z)$, using the impulse invariant technique for the analog system function :

$$H(s) = \frac{1}{(s+0.5)(s^2+0.5s+2)}$$

Assume T=1 sec. [7]

(c) Design a digital Butterworth filter that satisfies the following constraint, using bilinear transformation :

$$0.9 \le |H(e^{j\omega})| \le 1 \qquad 0 \le \omega \le \frac{\pi}{2}$$
$$|H(e^{j\omega})| \le 0.2 \qquad \frac{3\pi}{4} \le \omega \le \pi$$

Assume T=1 sec. [7]

(d) Design a Chebyshev filter that satisfies the following constraints, using bilinear transformation : [7]

$$0.8 \le |H(e^{j\omega})| \le 1 \qquad 0 \le \omega \le 0.2\pi$$
$$|H(e^{j\omega})| \le 0.2 \qquad 0.6\pi \le \omega \le \pi$$

Assume $T = 1$ sec.

5. (*a*) What is multirate DSP? [2]

(*b*) Explain the decimation and interpolation process in detail with example. [7]

(*c*) (*i*) For the multirate system shown in Fig., develop expression for the output $y(n)$ as a function of the input $x(n)$. [7]

(*ii*) Show that the following two systems are identical, if L and M are relatively prime :

Fig.(a)

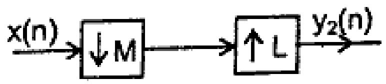

Fig.(b)

(*d*) Explain polyphase structures for decimators and interpolators. [7]

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