SVKM's NMIMS

MUKESH PATEL SCHOOL OF TECHNOLOGY MANAGEMENT & ENGINEERING

Programme: B. Tech (Computer) Year: III Semester: V

Batch: 2014-2015

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Subject: Digital Signal Processing

Date: 27/11/2015

Marks: 60

Time: 2.00 pm to 5.00 pm

Duration: 3 (Hrs)

Re-Examination

Instructions: Candidates should read carefully the instructions printed on the question paper and on the cover of the answer book, which is provided for their use

1. Question No. 1 is compulsory
2. Out of the remaining questions, attempt any four questions
3. In all 5 questions to be attempted
4. Answer to each question must be started on a new page
5. Figures on the right indicate full marks

Q1 a. The impulse response of a linear time-invariant system is 3

$$h(n) = \{1, 2, \underset{\uparrow}{1}, -1\}$$

Determine the response of the system to the input signal

$$x(n) = \{1, 2, \underset{\uparrow}{3}, 1\}$$

b. Prove that a discrete-time sinusoid is periodic only if its frequency f, is a rational number. 3

c. Why an ideal low pass filter cannot be realized in practice? 3

d. Compare the number of complex additions and complex multiplications in the direct computation of DFT and the FFT algorithm for an 8 point sequence. 3

Q2 a. Determine the causal signal $x(n)$ if its z-transform $X(z)$ is given by: 6

$$X(z) = \frac{1 + 3z^{-1}}{1 + 3z^{-1} + 2z^{-2}}$$

b. Compute the impulse response of the following causal system 6

$$y(n) = \frac{3}{4}y(n-1) - \frac{1}{8}y(n-2) + x(n)$$

Plot the pole-zero pattern. Is the system stable?

Q3 a. Determine if the following signals are power or energy signals? 6

(i) $x(n) = \left(\frac{1}{2}\right)^n u(n)$

(ii) $x(n) = 2e^{j3n}$

b. Compute the 8-point DFT of the sequence using the DIT – FFT algorithm 6

$$x(n) = \{\underset{\uparrow}{1}, 2, 1, 2, 0, 2, 1, 2\}$$

Q4 a. Design a digital Butterworth filter that satisfies the following constraint using Bilinear Transformation. Assume $T = 1s$. 6

$0.9 \le |H(e^{j\omega})| \le 1$ $\quad 0 \le \omega \le \pi/2$

$|H(e^{j\omega})| \le 0.2$ $\quad 3\pi/4 \le \omega \le \pi$

b. Draw the structures of cascade and parallel realizations of 6

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

Q5 a. A low pass filter is to be designed with the following desired frequency response 6

$$H_d(e^{j\omega}) = e^{-j3\omega}, \qquad -3\pi/4 \le \omega \le 3\pi/4$$
$$= 0, \qquad 3\pi/4 \le |\omega| \le \pi$$

Determine the filter coefficients $h(n)$ for M = 7 using a Hamming Window

b. Convert the analog filter with system function 6

$$H(s) = \frac{s + 0.1}{(s + 0.1)^2 + 9}$$

into a digital IIR filter using bilinear transformation. The digital filter should have a resonant frequency of $\omega_r = \pi/4$

Q6 a. (i) Find the DFT of $x(n) = \{\underset{\uparrow}{1}, 2, 3, 4\}$ 6

(ii) Using the results obtained in (i) and not otherwise find the DFT of

$$x(n) = \{\underset{\uparrow}{1}, 0, 2, 0, 3, 0, 4, 0\}$$

b. The first five points of the 8-point DFT of a real-valued sequence are $\{0.25, 0.125 - j0.3018, 0, 0.0125 - j0.0518, 0\}$. Determine the remaining three points. 3

c. Determine circular convolution of the sequences using the time domain approach 3

$$x_1(n) = \{\underset{\uparrow}{1}, 2, 3, 1\}$$

$$x_2(n) = \{\underset{\uparrow}{4}, 3, 2, 2\}$$

Q7 a. A discrete time system can be 3

(i) Static or dynamic
(ii) Linear or non-linear
(iii) Time invariant or time varying
(iv) Causal or non-causal

Examine the following system with respect of the properties above

$$y(n) = x(n) + nx(n + 1)$$

b. Prove the following 6

(i) $x_1(n) * x_2(n) \overset{Z}{\longleftrightarrow} X_1(z)X_2(z)$

(ii) $x_1(n) \otimes x_2(n) \xleftrightarrow{N\text{-point DFT}} X_1(k)X_2(k)$

c. Compare FIR and IIR Filters 3

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