Question Paper

Exam Date & Time: 05-May-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

IV SEM B. Tech (BME) DEGREE END SEMESTER EXAMINATIONS, MAY-2024

SUBJECT: DIGITAL SIGNAL PROCESSING (BME 2225)
(REVISED CREDIT SYSTEM)
May, 2024

DIGITAL SIGNAL PROCESSING [BME 2225]

Marks: 50 **Duration: 180 mins.**

Descriptive

Answer all the questions. Section Duration: 180 mins

Missing data if any can be assumed suitably.

Graphs have to be plotted on the sheets provided.

1A) Evaluate the 8-point DFT of the sequence **x(n)={1,1,1,1,0,0,0,0}** using ***Expansion method*** (4)

1B) Compute the ***circular convolution*** for the given sequence x(n) and h(n) using ***Stockham's method.*** (4)

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

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

1C) Identify any two applications of DSP (2)

2A) Evaluate the 8-point DFT of the sequence. (4)

x(n) = {1, 2, -1, 2, 4, 2 -1, 2} using the ***radix-2 DIF-FFT algorithm***.

2B) A long sequence x(n) is filtered through a filter with impulse response h(n) to give an output response y(n). (4)

If **x(n)= {1, 1, 1, 1, 1, 3, 1, 1, 4, 2, 1, 1, 3, 1}** and **h(n)= {1, -1}.** Evaluate y(n) using the ***overlap-add method***. Use ***only 5-point circular convolution*** in your approach

2C) Compute the number of multiplications and additions needed for a ***64-point sequence*** in the calculation of DFT using the FFT algorithm and also find SIF (Speed Improvement Factor) (2)

3A) State and prove ***circular time shifting*** property of DFT (4)

3B) Realize the given system function H(z) in a ***lattice ladder structure*** (4)

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

3C) Realize the system function H(z) in ***direct form structure for the given FIR filter*** (2)

$$H(z) = 1 + \frac{1}{4}z^{-1} + \frac{1}{3}z^{-2} + \frac{1}{4}z^{-3} + \frac{1}{8}z^{-4} + \frac{1}{9}z^{-5} + \frac{1}{7}z^{-6}$$

4A) Design a ***analog Butterworth low pass filter*** with ***-3dB*** cut-off frequency at ***500Hz*** and attenuation of ***-15dB*** at ***750Hz*** (4)

(Refer to Table Q1 for the required data)

Q1) Data for Butterworth filter

N	*Normalised Denominator Polynomial*
1	$(1+s)$
2	$(1+1.414s+s^2)$
3	$(1+s)(1+s+s^2)$
4	$(1+0.765s+s^2)(1+1.848s+s^2)$
5	$(1+s)(1+0.618s+s^2)(1+1.618s+s^2)$

4B) A ***digital low pass filter*** is required to meet the following specifications. (4)

$$20\log|H(W)|_{W=0.2\pi} \geq -1.9328dB$$

$$20\log|H(W)|_{W=0.6\pi} \leq -13.9794dB$$

Design H(z) to meet the following specs using the ***IIT (impulse invariant transform) method.***

(Refer to Table Q1 for the required data)

4C) If an input signal (2)

$$\boldsymbol{u(t) = 10\,cos(4\pi t) + cos(40\pi t) + sin(100\pi t) + 5\,sin(140\pi t)}$$

$0 \leq t \leq 1$ is given to the ADC, ***Compute*** the Sampling frequency required to reproduce the signal, and also plot the rough FFT plot for the given signal

5A) Explain the ***hamming window*** used in the design of FIR filters. Draw the impulse response and magnitude response. (5)

5B) Realize the given digital filter equation using Direct Form 2 structure (3)

$$H(z) = \frac{(1 - \frac{1}{2}z^{-1} + \frac{1}{4}z^{-2})}{(1 + \frac{1}{8}z^{-1} - \frac{1}{5}z^{-2} + \frac{1}{6}z^{-3})}$$

5C) Explain the ***Design Procedure for BLT (Bilinear transformation) Method*** with the help of a flowchart (2)

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