Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree Regular and Supplementary Examination December 2020

Course Code: EC301

Course Name: DIGITAL SIGNAL PROCESSING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Comment on the relationship between DTFT and DFT. (3)

b) Obtain the real sequence x(n) using DIT- IFFT algorithm if the first five points in the 8 point DFT of x(n) are given by {1.5, 0, 2+0.5j, 0, 0.5} (12)

2 a) Given two real sequences x(n)=[1 2 3 1] and y(n)=[2 1 2 1]. Compute the DFTs X(k) and Y(k) of these two sequences using a single DFT calculation. (7)

b) Given two sequences x[n] and y[n] such that x[n]=[2 2 0 2] and the 4 point circular convolution between x[n] and y[n] results in g[n]=[10 10 8 8] . Determine the sequence y[n]. (8)

3 a) Using overlap save method and 5 point circular convolutions, determine the response of an LTI system with impulse response $h(n) = u(n) + 2\delta(n-1) - u(n-3)$ for an input sequence $x(n) = \sum_{k=0}^{10} A_k \delta(n-k)$, where (9)

$A_k = 1$, for k even

$= 2$, for k odd.

b) Given the eight point DFT X(k) of a sequence x(n) as (6)

X(k)={1 2+j 1 -1+j 2+2j -1-j 1 2-j}.

Determine the following without directly computing the IDFT.

a) $\sum_{k=0}^{7} |x(n)|^2$

b) $x(4)$

PART B

Answer any two full questions, each carries 15 marks.

4 a) Design a low pass Butterworth digital filter using bilinear transformation for the given specifications (10)

PB region: 0 - 400Hz

SB region: 2.1 - 4 kHz

PB ripple:2dB

SB attenuation:20dB

Sampling frequency:10kHz

Obtain the transfer function of the digital filter.

b) An FIR filter function given by $H(z) = \frac{(1-z^{-1})}{2}$. Determine whether the filter function represents a low pass filter, high pass filter, bandpass filter or a band reject filter. (5)

5 a) The transfer function of an analog low pass filter is given by $H(s) = \frac{(s+0.2)}{(s^2+0.4s+9.04)}$. Obtain the transfer function of the equivalent digital filter using impulse invariant method. (Use T=1sec) (5)

b) Explain the characteristics of a Butterworth filter (3)

c) Design an FIR filter that realizes the frequency response given by (7)

$$H(\omega) = e^{-j\frac{5}{2}\omega}, \quad 0 \le |\boldsymbol{\omega}| \le \frac{\pi}{3}$$

$$0, \quad \frac{\pi}{3} \le |\boldsymbol{\omega}| < \pi$$

Using frequency sampling method, determine the filter coefficients.

6 a) Design a normalized linear phase FIR filter with a phase delay of τ=4, and atleast 50dB attenuation in the stopband. Also obtain its magnitude response. (10)

b) Compare IIR filters and FIR filters. (5)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Obtain parallel form realization of an IIR filter defined by the transfer function $H(z) = \frac{0.7-0.252z^{-2}}{1+0.1z^{-1}-0.72z^{-2}}$ (8)

b) Obtain the direct form II structure for $\text{H}(z) = \frac{0.1+0.1531z^{-1}-0.252z^{-2}}{1+0.215z^{-1}-0.662z^{-2}}$. Redraw the structure if the filter is realized on a fixed point processor using 8 bit word length in Q7 format. (Use truncation for quantization of the coefficients). (8)

c) Briefly explain the working of a MAC unit in a DSP processor with a neat diagram. (4)

8 a) Elaborate the possible errors that may arise when an FIR filter is realized on a finite word length processor. (7)

b) i.) Given an input sequence x(n)={1 3 2 5 2 8 5 1 9}, which is fed to an (8) interpolator with an upsampling factor L=3. Determine the output sequence.

ii.) Draw the block diagram of the interpolator (with an upsampling factor L=3) by correctly mentioning the cut-off frequency of the interpolation filter to be used, if the input signal is bandlimited to a frequency of $|\omega| \leq \frac{\pi}{4}$. Substantiate the need for the interpolation filter with necessary diagrams and explanations.

c) Differentiate between truncation and rounding with an example. (5)

9 a) Explain the limit cycle oscillation in recursive filters with an example. (4)

b) The lattice coefficients of a three stage lattice structure are given by $=K1 = \frac{1}{4}$, $K2 = \frac{1}{2}$, $K3 = \frac{1}{3}$. Obtain the direct form structure for the FIR filter. (8)

c) Obtain the direct form I, and its transposed structure for the IIR filter defined by the transfer function $H(z) = \frac{0.28z^2+0.32z+0.04}{0.5z^3+0.3z^2-0.12z+0.2}$ (8)

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