GLASGOW COLLEGE UESTC

Exam paper

Digital Signal Processing (UESTC4005)

Date: June 29th 2024
Time: 14:30-16:30

Attempt all PARTS. Total 100 marks

Use one answer sheet for each of the questions in this exam.
Show all work on the answer sheet.

Make sure that your University of Glasgow and UESTC Student Identification Numbers are on all answer sheets.

An electronic calculator may be used provided that it does not allow text storage or display, or graphical display.

All graphs should be clearly labelled and sufficiently large so that all elements are easy to read.

The numbers in square brackets in the right-hand margin indicate the marks allotted to the part of the question against which the mark is shown. These marks are for guidance only.

Continued overleaf

Q1 It is known that the even point DFT value of a 7-point DFT of a real length-7 sequence $x[n]$ is $X[0]=4.8, X[2]=3.1+j2.5, X[4]=2.4+j4.2, X[6]=5.2+j3.7$.

(a) Determine the odd point DFT value of the sequence. [6]

(b) Determine the value of $x[0]$. [4]

(c) Suppose a sequence $y[n]=x[\langle n-3\rangle_7]$, determine the value of $Y[5]$. [6]

(d) If we do zero-padding to x[n] to make x[n] be length-8 , then use the radix-2 Decimation-in-Time Fast Fourier Transformation (DIT FFT) algorithm to get its 8-point DFT $X'[k]$,

(i) Is $X'[k]$ the same as $X[k]$?Why? [4]

(ii) Evaluate the total number of complex multiplications and additions during the radix-2 DIT FFT algorithm. [5]

Continued overleaf

Q2 A zero-pole plot of 😕 a causal LTI system is shown in Fig2.1. It is known that when $z=1$, $H(z)=6$.

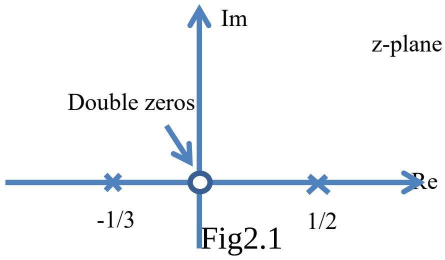

Fig2.1

(a) Is the system stable? Why? [4]

(b) Determine the transfer function $H(z)$ of the system. [6]

(c) Determine the difference equation of the system. [4]

(d) Determine the impulse response $h[n]$ of the system. [5]

(e) Evaluate the response(in terms of $h[n]$) of the system for the following input:

The sampled version of a continuous time signal $x(t)=50+10\cos 20\pi t+30\cos 40\pi t$, with sampling rate being $\Omega_T=2\pi(40) rad/s$ and for $0 \le n \le 3$. [6]

Continued overleaf

Q3 A typical transmission channel is characterized by a causal transfer function

$$H(z) = \frac{(2.2+5z^{-1})\ (1-3.1z^{-1})}{(1+0.81z^{-1})\ (1-0.62z^{-1})}.$$

(a) The system is a minimum-phase system, maximum-phase system or mixed-phase system? Why? [8]

(b) If the system is not minimum-phase and we want to make it be a minimum-phase system with the same magnitude characteristic as the original system， how can we do? Determine the transfer function $H_{min}(z)$ of the minimum-phase system you find. [9]

(c) In order to correct for the magnitude distortion introduced by the channel on a signal passing through it, we wish to connect a causal digital filter characterized by a transfer function $G(z)$ at the receiving end. Determine $G(z)$.

[8]

Q4 A linear phase lowpass FIR filter is wanted to process analog signals. It's specification is： $f_p=4kHz$, $f_s=4.5kHz$, $\delta_p=0.0114$, $\delta_s=0.0056$, Sampling rate $f_T=20kHz$. The windowed Fourier Series method should be used.

(a) Determine **the peak passband ripple** α_p and **the minimum stopband attenuation** α_s of this filter. Which of the two specifications should be used for window selection, why? [6]

(b) Determine the band edge frequencies of the digital filter. [3]

(c) Choose a suitable fixed window to meet the specifications, and Determine its length. [6]

(d) Write down the impulse response of the designed FIR filter.. [6]

(e) What type of linear phase system is this filter？ [4]

End of question paper