山东大学 2019-2020 学年 第 一 学期 数字信号处理原理 课程试卷（A）

姓名 学号 级 专业 学院

密 封 线

题号	一	二	三	四	五	六	七	八	九	十	总分	阅卷人
得分												

备注： 闭卷，可以带计算器

得分	阅卷人

一、 Fill the blanks(40%)

1. Let there is a continuous time sequences x(t)= x1(t)+ x2(t)+ x3(t) with two continuous components, x1(t)= cos(3πt), x2(t)= cos(7πt), x3(t)= cos(10πt), if the combined digital signal is x[n]= x1[n]+ x2[n]+x3[n], then

(1) if sampled by 10Hz, then the signal will get aliasing or not __no ①____and then sampled signal in time domain x[n]=___cos(0.3πn)+cos(0.7πn)+cos(πn) ②____;

(2) based on (1) , to filter the x1[n] by passing x[n] through a digital filter, choose one kind of digital filter ③ LPF __and determine its cut-off frequency____④ $0 \le \omega \le 0.7\pi$_

(3) based on (2), determine the period of x1[n], N=___20 ⑤____.

2. If $x[n] = \{1, 4, 5, -4, -1\}, -2 \le n \le 2$, then

(1) x[n] can be expressed in terms of the unit impulse signal $\delta[n]$ as __$x[n] = \delta[n+2] + 4\delta[n+1] + 5\,\delta[n] - 4\,\delta[n-1] - \delta[n-2]$_⑥______;

(2) If the impulse response of a LTI system is h[n]= $\{1, 4, 5\}$, $0 \le n \le 3$, then given by x[n], the output sequence y[1]=_⑦ 36__and the range of y[n] is between ___⑧ -2____and_⑨ 4 ;

(3) if calculate $y_c[n]$ by 6-points circulation convolution, the value of $y_c[1]$= _⑩ -8;

(4) without computing the DTFT, $X(e^{j0})$ = _5 ⑪__; $\int_{-\pi}^{\pi} |X(e^{j\omega})|^2 d\omega$=___84π_⑫___;

(5) to make h[n] to be a Type1 linear phrase FIR, then write out one of the possible new linear phase h′[n]=___⑬ {-1,4,5,-4,1} .

(5) Without computing the DTFT, determine what kind of $X(e^{j\omega})$ is real-valued ⑭;___ (real-valued or imaginary-valued or others types of DTFT).

3. If x[n] is a length-120 sequence and h[n] is a FIR filter with $0 \le n \le 4$. If using 10-points overlap method to computer y[n] , then the length of each small segment of x[n] is __6 ⑮__and their whole length output y[n] is ⑯20 .

4. Some samples of the 5-point DFT of a length-5 real sequence are given by X[0]=-4.7, X[2]=1.2-j2, X[4]=-3.5+j3. The X[1] should be __________⑰ -3.5-3j__________.

5. An IIR digital filter has the unit pulse response $h[n] = (0.5)^n \mu[-n] + (0.2)^n \mu[n]$, then

$$\frac{1}{1+0.5z} + \frac{1}{1+0.2z^{-1}} \qquad 0.2 < |z| < 2$$

(1) z-transform of H(z) in closed form is ___⑱_______ and its R.O.C is ____⑲_______.

(2) whether h[n] is BIBO stable or not ___⑳stable .

得分	阅卷人

二、Comprehensive problems(60%)

Lingy

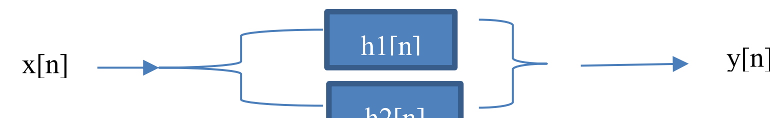
1. (40%)A causal LTI system is described by the recursive difference equation

$$y[n] = 2x[n] - x[n-1] + \frac{7}{12}y[n-1] - \frac{1}{12}y[n-2]$$

(1) Find the transfer function of H(z) and its R.O.C.(6%)

$$H(z) = \frac{2 - z^{-1}}{1 - \frac{7}{12}z^{-1} + \frac{1}{12}z^{-2}}, R.O.C\ |z| > \frac{1}{3}$$

(2) Draw the diagram of the system in parallel form. (8%)



$$h1[n] = \frac{-4}{7}\left(\frac{1}{3}\right)^n u[n]$$

$$h2[n] = \frac{6}{7}\left(\frac{1}{4}\right)^n u[n]$$

(3) If using bilinear form to transfer the digital filter to analog filter, write out the transform equation. (4%)

$$z = \frac{2 + T \cdot s}{2 - T \cdot s}$$

(4) Find the impulse response h[n] by solving differential equations. (8%)

$y_h[n] = h[n] = \alpha_1 \left(\frac{1}{3}\right)^n + \alpha_2 \left(\frac{1}{4}\right)^n$, x[0]= δ[0], y[0] = 2; x[1]= δ[1], y[1]=-1,

$$h[n] = -18\left(\frac{1}{3}\right)^n + 20\left(\frac{1}{4}\right)^n$$

(5) Write out the magnitude function of the frequency response $H(e^{j\omega})$.(6%) $z = e^{j\omega}$代入

(6) If using FIR filter to approximate h[n] and N=10, then what its magnitude function of the frequency response $H(e^{j\omega})$ will be. (6%) $H(e^{j\omega}) = \sum_{n=1}^{N} h[n] e^{j\omega n}$

(7) How to make (6) to be linear phase.(2%) h’[n]=h[N-n]

2. (20%) For a continuous time signal x(t) with frequency spectrum X(jΩ), which $-\pi \times 10^4 r/s \le \Omega \le \pi \times 10^4 r/s$ as figure 1 shown.

(1) Plot corresponding frequency spectrum of $X(e^{j\omega})$ and $X_s(j\Omega)$ with a proper sampling period $T = 0.5 \times 10^{-4}$s（5%). $\Omega_T = \frac{2\pi}{T} = 4\pi \times 10^4 r/s$, $\omega_{max} = \Omega_{max} T = \pi \times 10^4 \times 0.5 \times 10^{-4} = 0.5\pi$

(2) If there is a LPF $H(e^{j\omega})$ with cut-off frequency $-\pi/4 \le \omega_c \le \pi/4$, Plot the frequency spectrum of $Y(e^{j\omega})$and its 10-points DFT Y[k] .(5%) k 为 1 或-1

(3) Determine the range of sampling rate Ω_s if $Y_s(j\Omega)$ is reconstructed by filter in (2)without aliasing.

and Draw the $Y_s(j\Omega)$ based on (3). (5%) $\begin{cases} \frac{\omega_{cc}}{T} \le \frac{2\pi}{T} - \Omega_{max} \\ \frac{\omega_{cc}}{T} \le \Omega_{max} \end{cases} \rightarrow \frac{1}{4} \times 10^{-4}s \le T \le \frac{7}{4} \times 10^{-4}s$

if chose T= $T = 0.5 \times 10^{-4}$s, then $\Omega_{y\_max} = \frac{\omega_{y\_max}}{T} = \frac{\frac{\pi}{4}}{0.5 \times 10^{-4}} = 0.5\pi \times 10^4 r/s$

(4) Design an antialiasing filter if $T = 0.2 \times 10^{-4}$s and plot the frequency spectrum of Xs(jΩ)after using anti-

aliasing filter . (5%) $H_a(j\Omega) = \begin{cases} 1, & |\Omega| < \frac{\Omega_T}{2} = \frac{\frac{2\pi}{0.2\times 10^{-4}}}{2} = 5\times 10^{-4}\pi, \\ 0, & |\Omega| \geq \frac{\Omega_T}{2}. \end{cases}$,

$$X_{anti}(j\Omega) = H_a(j\Omega)X(j\Omega)$$