上海电力大学试卷

学年学期	2022-2023 学年第 一 学期			考核方式	开卷笔试 （非现场考试）
				开卷物品	复习材料，教材，参考书
课程名称	数字信号处理			任务类型	正考
课程号	2607017.01	学分	3	A/B 卷	A
题号	一	二		三	总分
分数					

考前阅读注意事项：

1. 本试卷满分为 100 分。
2. 试题无需在答题纸上抄写，注明每道小题的题号，直接将解答写在答题纸上。
3. 考试截止时间之前，将答题纸拍照上传课程考试平台，过期因系统关闭无法上传的话后果自负。拍照注意清晰可辨，否则会影响评阅。
4. 原则上应在提前打印好的答题纸上填写相关信息，并在诚信考试承诺处签名；

如确有困难无法提前打印，可采用 A4 白纸按照答题纸规范手动抄写模板。如果答题纸一页不够写，需在页脚标明页码（写清楚共几页，第几页），并确保每一页均注明本人姓名学号。

以下为试题区。

一、问答题（共 20 题，每小题 1 分，共 20 分）

1. What is the math relationship between analog signal $x_a(t)$ and its sampled discrete time signal $x(n)$

2. Definition of discrete unit step function $u(n)$? What is the relationship between discrete unit step function and unit impulse function ?

3. Relationship between digital frequency ω and analog frequency Ω in the context of DSP

4. Math expression for a discrete signal $x(n)$ using discrete impulse function $\delta(n)$?
5. Math equations for DTFT transform and its inverse transform
6. For single pole at z_k , write out the expression for its residue at z_k , according to the residue theorem.
7. What is the **final value theorem** in z-transform? write out its math equation.
8. Math expression for DFT and inverse DFT
9. Summarize what it means by implicit periodicity of $x(n)$ and $X(k)$ in DFT.
10. What is the frequency sampling theorem ? give a short summary.
11. What is the reverse-order number ? given a example to illustrate.
12. What are the basic components (equations) in state space analysis method ?
13. In the spectrum analysis using DFT, what is the frequency resolution ?
14. Using DIT-FFT method to calculate DFT, what is number of times of multiplication and addition ?
15. What is the property of the signal flow diagram for IIR system ?
16. What are the main design methods for IIR filter design ?
17. What is the result by the command “0:0.2:0.9”
18. In subplot(223), what is the plot location. Draw a diagram to illustrate.
19. What does the command "conv" do ?
20. If A is a 10x10 matrix, write a single line of command to assign its submatrix (row 2 and 5, columns from 3 to 6) to a new matrix B

二、 计算题（共 5 题，每小题 10 分，共 50 分）

Q1 (10 marks)

For a finite length sequence $x(n) = 2\,n[u(n) - u(n-5)]$,

(1) Find the sequence $x_1(n) = x((n-3))_5\, R_5(n)$

(2) Find the linear convolution $y(n) = x(n) * x_1(n)$

(3) Find 5 point cyclic convolution $y_1(n) = x(n) \otimes x_1(n)$ where '⊗' denote cyclic convolution

Q2 (10 marks)

Let $X(k)$ be the 6 point DFT of a **real** sequence $x(n)$ where

$X(0) = 1$, $X(1) = 3 + j$, $X(2) = 5 - j$, and $X(3) = 2$.

(1) Find the values for the entire sequence of $X(k)$

(2) If another sequence $x_1(n) = x((n-3))_6\, R_6(n)$, find the sequence $X_1(k) = \mathrm{DFT}(x_1(n))$

Q3 (10 marks)

For a discrete filter, its frequency transfer function is given by

$$H(\omega) = \begin{cases} e^{-j3\omega} & |\omega| \le \frac{\pi}{3} \\ 0 & \text{otherwise} \end{cases}$$

Find the impulse response $h(n)$ of the filter

Q4 (10 marks)

A continuous system has transfer function given by

$H(s) = \frac{1}{(s+2)(s+3)}$

Use bilinear transformation method to find the corresponding transfer function in discrete time domain using the sampling period $T_s = 1$ s

Q5 (10 marks)

In a spectrum analysis experiment for a real signal, the required frequency resolution $F \le 50$ Hz and the maximum none-zero frequency component contained in the signal is 2 kHz. Determine the following parameters for the experiment

(1) the minimum recording time $T_{\min}$ and the maximum sampling interval $T_{\max}$

(2) the minimum sampling points $N_{\min}$

(3) with the same sampling frequency, the minimum number of points N in order to reduce the frequency resolution by half (that is $F \le 25$ Hz).

三、 综合题（共 2 题，每小题 15 分，共 30 分）

Q1 (15 marks)

For a given continuous time signal $x_a(t) = \cos(100\,\pi\,t)$, use the sampling frequency $f_s = 200$ Hz to get the sampled signal in a continuous form $\hat{x}_a(t)$, or in the discrete time form $x(n)$.

(1) write out the math expression for $\hat{x}_a(t)$ and $x(n)$, respectively.

(2) find the Fourier transforms for all the three signals above.

(3) discuss the relationships between these signals and support your arguments with appropriate math equations.

Q2 (15 marks)

A FIR filter is given by the following system equation

$$H(z) = \frac{1}{5} \times \left(1 + 2\,z^{-1} + 4\,z^{-2} - 4\,z^{-3} - 2\,z^{-4} - z^{-5}\right)$$

(1) Determine the impulse response $h(n)$ of the filter, and determine whether it is linear phase or not ? explain what type of linear phase the filter belongs to ?

(2) find $H(\omega)$ in terms of its magnitude (can be negative) and phase

(3) draw a diagram for direct and linear phase filter structure, and compare these two structures to show the main advantages of linear phase structure over the direct form