**Student Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
Student Number: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
School: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
Year of Entrance: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**ShanghaiTech University Midterm Examination Cover Sheet**

Academic Year : \_\_\_2023\_\_\_to\_\_2024\_\_\_\_\_ Term: \_\_\_\_\_\_\_Fall\_\_\_\_\_\_\_\_

Course-offering School: \_\_\_\_\_\_SIST\_\_\_\_\_\_\_\_\_\_\_\_

Instructor: \_\_\_\_\_\_Lin Xu, Xiran Cai \_\_\_\_\_\_\_\_\_\_\_\_\_

Course Name: \_\_\_\_\_\_\_\_Signals and Systems\_\_\_\_\_\_\_\_\_\_\_\_

Course Number: \_\_\_\_\_\_\_EE150\_\_\_\_\_\_\_\_\_

**Exam Instructions for Students:**1. All examination rules must be strictly observed throughout the entire test, and any form of cheating is prohibited.

2. Other than allowable materials, students taking closed-book tests must place their books, notes, tablets and any other electronic devices in places designated by the examiners.

3. Students taking open-book tests may use allowable materials authorized by the examiners. They must complete the exam independently without discussion with each other or exchange of materials.

**For Marker’s Use:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Section** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **Total** |
| **Marks** |  |  |  |  |  |  |  |  |  |  |  |
| **Recheck** |  |  |  |  |  |  |  |  |  |  |  |

**Marker’s Signature: Rechecker’s Signature:**

**Date: Date:**

**Instructions for Examiners:**

1. The format of the exam papers and answer sheets shall be determined by the school and examiners according to actual needs. All pages should be marked by the page numbers in order (except the cover page). All text should be legible, visually comfortable and easy to bind on the left side. A4 double-sided printing is recommended for the convenience of archiving (There are all-in-one printers in the university).

2.The examiners should make sure that exam questions are correct and appropriate, If errors are found in exam questions during the exam, the examiners should be responsible to respond on site, which will be taking into account in the teaching evaluation.

1. (20 points)

Fill out the blank area. Note that denotes convolution, and are the unit step function and unit impulse function, respectively.

1. . (6 points)
2. If , then (Hint: fill in an expression of ). (7 points)
3. If the unit step response of a discrete-time LTI system is , then the unit impulse response of the system is . (7 points)
4. （20 points）

Given the system described by , where is the input signal and is the output signal.

1. Is the system linear and time-invariant? Motivate your answer. (9 points)
2. Find the impulse response of the system. (5 points)
3. Is the system causal and stable? Motivate your answer. (6 points)
4. (20 points)

Given the signal

(a) What is the period of ? (2 points)

(b) Determine the Fourier series coefficients of . (11 points)

(c) The frequency response of a discrete-time LTI system is . What is Fourier series coffefficients of the output signal if the input of the system is . (7 points)

1. (20 points)
2. Given that , prove that . (IFT: inverse Fourier transform). (4 points)
3. , find . (8 points)
4. is a real signal. Find the combination of and whose Fourier transform equals to and , respectively. Note that and are the functions taking the real and imaginary part of a complex number, respectively. (8 points)
5. (20 points)

The LTI system described by the following differential equation is stable (Note that is the unit impulse signal)

1. Find the frequency response of the system and its inverse Fourier transform . (12 points)
2. Find the output of the system given the input . (8 points)