UESTC Student ID____________________ UOG Student ID____________________ Course Title________________________ Lecturer________________

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GLASGOW COLLEGE UESTC

Final Exam

Signals and Systems(2026) — Semester 2, 2018 - 2019

Date: 2nd July, 2019

Time: 09:30-11:30am

Notice: Attempt all PARTS. Total 100 marks. Please make sure that both your UESTC and UOG Student IDs are written on the top of every sheet. The use of a calculator or a cell phone is not permitted. Unless indicated otherwise, answers must be derived or explained clearly. All graphs should be clearly labelled and sufficiently large so that all elements are easy to read. Please write within the space given below on the answer sheets.

The following table is for grader only:

Question	**1**	**2**	**3**	**4**	**5**	**Total**
Score						

Question 1 (5x4=20 points) For each of the following questions, there exists only one right answer. Justify your answers and write it in the parenthesis of each sub-question.

Score

（1）Determine which system listed in flowing is causal and time invariant. (　　　)

(a) $y(t)=x(t-2)+x(2-t)$　　　**(b)** $y(t)=[\cos 3t]x(t)$

(c) $y(t)=\int_{-\infty}^{2t} x(\tau)d\tau$　　　**(d)** $y(t)=\dfrac{dx(t)}{dt}$

（2）Let $X(j\omega)$ be the Fourier transform of a square wave pulse defined by $x(t)=u(t)-u(t-1)$. Suppose that a signal generator is used to generate a periodic square wave signal related with $x(t)$ by $y(t)=\sum_{n=-\infty}^{+\infty} x(t-2n)$, then the Fourier series a_k for the periodic signal $y(t)$ is related with the Fourier transform of the aperiodic signal $x(t)$ as (　　　).

(a) $a_k = X(jk\pi)$　　**(b)** $a_k=\frac{1}{2}X(jk\pi)$　　**(c)** $a_k=\frac{1}{2}X(j2k\pi)$　　**(d)** $a_k = X(j2k\pi)$

（3）Consider two signals $x_1(t)$ and $x_2(t)$, as shown in Figure 1. The Fourier transform of $x_1(t)$ is $X_1(j\omega)$. Then the Fourier transform of $x_2(t)$ should be (　　　)

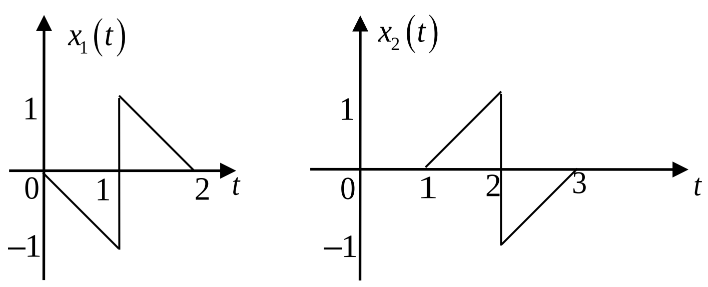

Figure 1.

(a) $X_1(-j\omega)e^{-3j\omega}$　　**(b)** $X_1(j\omega)e^{3j\omega}$　　**(c)** $X_1(j\omega)e^{-j\omega}$　　**(d)** $X_1(-j\omega)e^{j\omega}$

（4）A continuous-time LTI causal has system function $H(s)=\dfrac{s-1}{s+1}$, so the system is a (　　　)

(a) Low-pass filter　　**(b)** High-pass filter　　**(c)** Band-pass filter　　**(d)** All-pass filter

（5）Considering a stable discrete-time system, whose system function $\mathrm{H(z)}$ is a rational function and has only two poles: $z_1=\frac{1}{2}$ and

$z_2 = -2$. The positions of zeros are unknown. The impulse response $h[n]$ of the system must be ( ).

(a) Finite duration **(b)** Right-sided **(c)** Two-sided **(d)** Left-sided

Question 2 (20 points) Consider a signal $x(t)$ with Fourier transform $X(j\omega)$. Suppose we are given the following facts:

Score

(a) $x(t)$ is real and nonnegative.

(b) $F^{-1}\{(1+j\omega)X(j\omega)\}=Ae^{-2t}u(t)$,where A is independent of t.

(c) $\int_{-\infty}^{+\infty}|x(j\omega)|^2 d\omega = 2\pi$.

Design a signal $x(t)$, please express it with a closed-form expression.

Question 3 (20 points) Consider a system illustrated in Figure 2. The input signal to the system is described in the time-domain as $x(t)=\left(\frac{\sin(\pi t)}{\pi t}\right)^2$. It is filtered by an ideal low pass filter $h_1(t)=\frac{\sin(\pi t)}{\pi t}$ before being frequency-shifted by a $\cos(\pi t)$ signal. After that, the signal is impulse train sampled with $p(t)=\sum_{n=-\infty}^{+\infty}\delta(t-n/2)$. Finally, $h_2(t)$ is another ideal low-pass filter for signal reconstruction.

Score

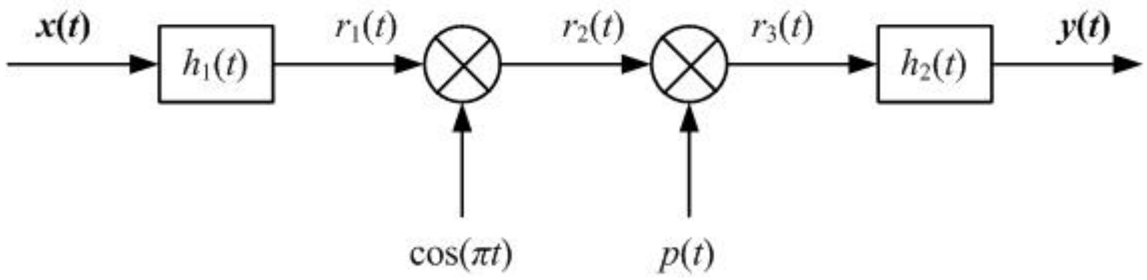

Figure 2.

Sketch the spectrum of $r_1(t)$, $r_2(t)$, $r_3(t)$, and $y(t)$.

Question 4 (20 points) Consider one initial rest LTI system with input $x(t)$, output $y(t)$, characterized by a linear constant coefficient differential equation $\frac{d^2y(t)}{dt^2}+2\frac{dy(t)}{dt}+y(t)=\frac{d^2x(t)}{dt^2}-\frac{dx(t)}{dt}-6x(t)$.

Score

(a) Determine the system function of this LTI system. (5 points)

(b) Plot the pole-zero pattern and indicate the region of convergence.(5points)

(c) Is this system stable? Please give a brief explanation. (5 points)

(d) Draw a block diagram representation for this LTI system.(5 points)

Question 5 (20 points) Considering a practical causal LTI system described by the following difference equation $y[n]-(1-k)y[n-1]=x[n]$, where k is a constant.

Score

Try to:

(a) Determine the value range of k to make the system stable (7 points)

(b) Determine y[n] if k=1/2 and $x[n]=\left(\frac{2}{3}\right)^n$ for all n (6 points)

(c) Determine y[n] if k=1/2 and $x[n]=\left(\frac{2}{3}\right)^n u[n]$ for all n (7 points)