The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: DMX4411 – Signal processing**
Academic Year	: 2019/2020
Date	: 04th October 2020
Time	: 13:30-16:30 hrs.
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7)** questions in **Four (4)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test **(CBT).**
6. The symbols used in this paper have their usual meanings.
7. Clearly state any assumptions that you may make.
8. Answers should be in clear handwriting.
9. Do not use red colour pen.

Question 1.

i. Distinguish between a periodic signal and a non-periodic signal. Moreover, write an expression for those signals in reference to continuous-time signals and discrete-time signals.

ii. With proper justification, determine whether each of the following signals are periodic or non-periodic? If the signal is periodic, find its fundamental period.

a) $x(t) = \cos\left(t + \frac{\pi}{4}\right)$

b) $x(t) = \cos t + \sin\sqrt{2}\,t$

c) $x[n] = \cos\left(\frac{\pi}{3}\right)n + \sin\left(\frac{\pi}{4}\right)n$

d) $x[n] = \cos^2\frac{\pi}{8}n$

iii. What does mean by a discrete type system? Moreover, show the block diagram representation and the mathematical representation of a discrete type system.

iv. Write two factors that should be fulfilled by a system to become a linear system.

v. As shown in Figure 1, determine whether the system is a linear system.

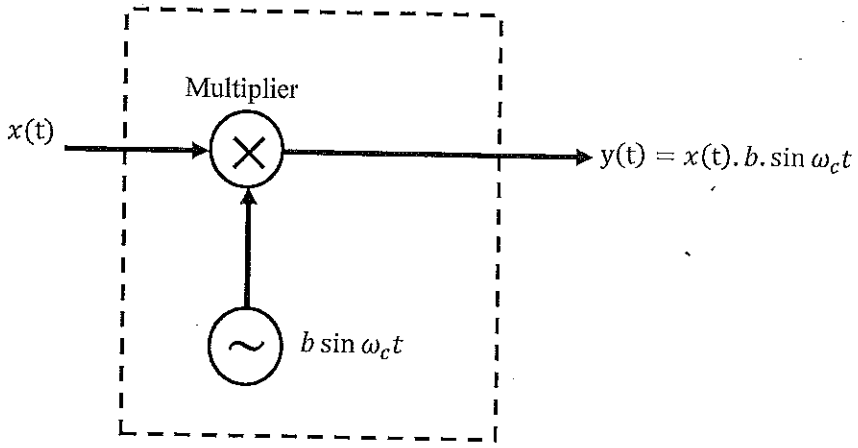

Figure 1: Time-domain system

(20 Marks)

Question 2.

i. The discrete-time system shown in Figure 2 is known as the *unit delay* element. Determine whether the system is;

a) memoryless

b) causal

c) linear

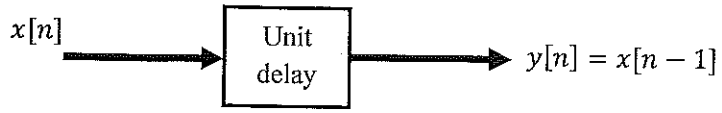

Figure 2: Unit delay system

ii. The discrete-time system shown in Figure 3 consists of two unit delay elements and two scalar multipliers. Write a difference equation that relates the output $y[n]$ and the input $x[n]$.

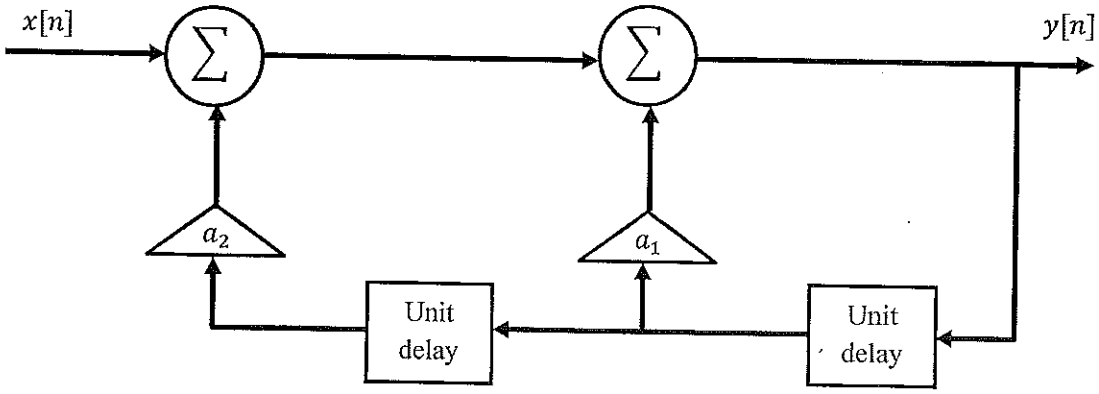

Figure 3: Discrete-time system

(20 Marks)

Question 3.

i. The impulse response $h[n]$ of an LTI system is $\beta^n u[-n-1]$, where $\beta > 1$. Determine the output $y[n]$ of the LTI system if the input $x[n]$ is $u[n]$.

ii. Using the answer in (i) or any other means, find the output of the LTI system if;

a) $h[n] = 3^n u[-n-1]$ and $x[n] = u[n-3]$

b) $h[n] = 2^n u[-n-3]$ and $x[n] = u[n] - u[n-1]$.

(20 Marks)

Question 4.

i. Briefly discuss the difference between Fourier series and Fourier transformation

ii. If $x(t)$ is a periodic signal with a fundamental period T_0 write an expression for the Complex Exponential Fourier Series and Trigonometric Fourier Series.

iii. In continuous-time Fourier transform

a) list three basic properties

b) write mathematical expressions for the properties mentioned in iii (a).

iv. Find the Fourier transform of the following;

a) real exponential, $x(t) = e^{-\beta t}\, u(t) \qquad a > 0$

b) rectangular pulse, $x(t) = \begin{cases} 1, & -T \le t \le T \\ 0, & |t| > T \end{cases}$

c) $x(t) = e^{\beta t}\, u(-t), \qquad a > 0$

(20 Marks)

Question 5.

Consider the periodic square wave $x(t)$ shown in Figure 4.

a) Determine the complex exponential Fourier series of $x(t)$

b) Determine the trigonometric Fourier series of $x(t)$.

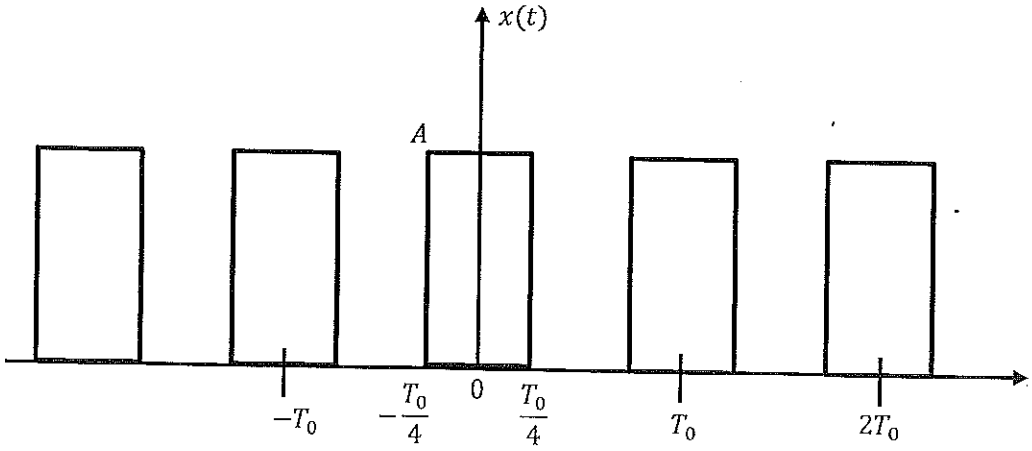

Figure 4: periodic square wave $(x(t))$

(20 Marks)

Question 6.

i. What does mean by LTI system in reference to system analysis

ii. For a given input signal $\delta(t)$ a continuous-time LTI system (represented by T) has the impulse response $h(t)$:

a) write an expression for the relationship of $\delta(t)$ and $h(t)$

b) list three properties of a discrete-time LTI system

iii. What does mean by "convolution sum" in reference to signals and systems

iv. Briefly explain the use of z-transform in reference to signals and systems

v. For a discrete-time LTI system if $x[n]$ is a general discrete-time signal

a) write an expression for $X(z)$

b) if $x[n] = a^n u[n]$ then find $X(z)$. (where a is real):

(20 Marks)

Question 7.

A Full wave rectifier is a circuit arrangement which makes use of both half cycles of input Alternating Current (AC) and converts them to Direct Current (DC). Figure 5 shows the rectified DC output waveform.

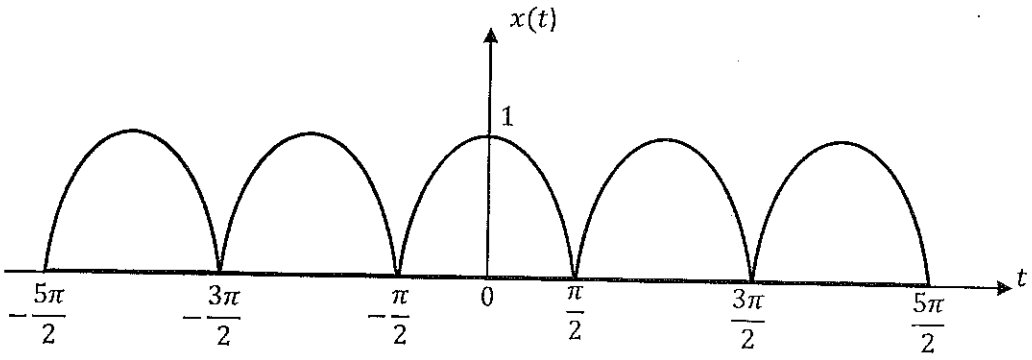

Figure 5: full-wave rectified cosine function

a) Determine the trigonometric Fourier series expansion of the full-wave rectified cosine function shown in Figure 5.

b) Derive the corresponding exponential Fourier series.

c) Draw the complex Fourier spectrum

(20 Marks)

END