Philadelphia University

Faculty of Engineering

Student Name:
Student Number:
Serial Number:

Final Exam, First Semester: 2019/2020
Dept. of Communication & Electronics Engineering

Course Title:	Signals and Systems	**Date:**	30/01/2020
Course No:	650320 +640543	**Time Allowed:**	2 hours
Lecturer:	Dr. Qadri Hamarsheh	**No. Of Pages:**	8

Instructions:
- **ALLOWED**: pens, calculators and drawing tools (**no red color**).
- **NOT ALLOWED**: Papers, literatures and any handouts. Otherwise, it will lead to the non-approval of your examination.
- **Shut down** Telephones, and other communication devices**.**

Please note:
- *This exam paper contains 7 questions totaling 40 marks*
- *Write your name and your matriculation number on every page of the solution sheets.*
- *All solutions together with solution methods (explanatory statement) must be inserted in the labelled position on the solution sheets.*
- *You can submit your exam after the first hour.*

Basic Notions: *The aim of the questions in this part is to evaluate the required minimal student knowledge and skills. Answers in the pass category represent the minimum understanding of basic concepts: Mathematical Models of LTI continuous and discrete systems, Convolution, Linear Constant-Coefficient Difference and Differential Equation, Laplace transform, Fourier Series, Fourier Transform and their computation methods and representations.*

<u>Question1</u> **Multiple choices (circle the most appropriate one):** ***(10 marks)***

1) The fundamental period of the sinusoidal DT signal: $x[n] = \sin\left(\frac{\pi n}{12} + \frac{\pi}{4}\right)$ is

a) 4 **b)** 8
c) 12 **d)** 24

2) Let $\delta(t)$ denote the delta function. The value of the integral $\int_{-\infty}^{\infty} \delta(t) \cos\left(\frac{3t}{2}\right) dt$ is

a) 0 **b)** 1
c) -1 **d)** $\pi/2$

3) If $x[n] = \begin{Bmatrix} 1, & 0 \le n \le 4 \\ 0, & Otherwise \end{Bmatrix}$, describe $x\,[n]$ as superposition of two step functions.

a) $x\,[n] = u\,[n] - u\,[n-5]$ **b)** $x\,[n] = u\,[n-5] - u\,[n]$
c) $x\,[n] = u\,[n-5] + u\,[n]$ **d)** $x\,[n] = u\,[n] + u\,[n-5]$

4) Which one of the following systems is **causal**?

a) $y(t) = x(t) + x(t-3) + x(t^2)$ **b)** $y(n) = x(n+2)$
c) $y(n) = x(2n^2)$ **d)** $y(t) = x(t-1) + x(t-2)$

5) A discrete linear time-invariant system is Bounded Input, Bounded Output (BIBO) **stable** if

a)	$\sum_{k=-\infty}^{\infty} \lvert y[k] \rvert < \infty$
b)	$\sum_{k=-\infty}^{\infty} \lvert h[k] \rvert < \infty$
c)	$\sum_{k=-\infty}^{\infty} \lvert y[k] \rvert \le \sum_{k=-\infty}^{\infty} \lvert h[k] \rvert$
d)	$\sum_{k=-\infty}^{\infty} \lvert y[k] \rvert \le \sum_{k=-\infty}^{\infty} \lvert x[k] \rvert$

6) The step response of a system can be written as

a)	$s(t)=u(t)h(t)$
b)	$s(t)=u(t)*h(t)=\int_{-\infty}^{\infty}\delta(t)h(t-\tau)d\tau$
c)	$s(t)=u(t)*h(t)=\int_{-\infty}^{\infty}u(\tau)h(t-\tau)d\tau$
d)	**None of above**

7) Determine the convolution sum of two sequences $\mathbf{x(n)} = \{\mathbf{3, 2, 1, 2}\}$ and $\mathbf{h(n)} = \{\mathbf{1, 2, 1, 2}\}$

a) **y(n) = {3, 8, 8, 12, 9, 4, 4}**
b) **y(n) = {3, 8, 8, 1, 9, 4, 4}**
c) **y(n) = {3, 8, 3, 12, 9, 4, 4}**
d) **y(n) = {3, 8, 8, 12, 9, 1, 4}**

8) The Fourier series of an odd periodic function, contains only

a) **Sine terms** **b)** **Cosine terms**
c) **Odd harmonics** **d)** **Even harmonics**

9) If $\mathbf{x(n)=Ae^{j\omega n}}$ is the input of an **LTI** system and **h(n)** is the response of the system, then what is the output **y(n)** of the system?

a) $H(-\omega)x(n)$ **b)** $-H(\omega)x(n)$
c) $H(\omega)x(n)$ **d)** **None of the mentioned**

10) If $\boldsymbol{Y(s)}$ is the Laplace-transform of the output function, $\boldsymbol{X(s)}$ is the Laplace-transform of the input function and $\boldsymbol{H(s)}$ is the Laplace-transform of system function of the **LTI s**ystem, then $\boldsymbol{H(s)} =$?

a) $X(s)/Y(s)$ **b)** $Y(s)/X(s)$
c) $Y(s).X(s)$ **d)** **None of the mentioned**

***Familiar and Unfamiliar Problems Solving**: The aim of the questions in this part is to evaluate that the student has some basic knowledge of the key aspects of the lecture material and can attempt to solve familiar and unfamiliar problems of Mathematical Models of LTI discrete systems, Convolution, Linear Constant-Coefficient Difference and Differential Equation, Laplace transform, Fourier Series, Fourier Transform and their computation methods and representations*

Question 2 **(5 marks)**

a) In particular, a system may or may not be **Linear, Time-invariant** and **Causal**. Determine which of these properties hold which do not hold for each of the following signals. In each example, $\boldsymbol{y}\ (\boldsymbol{t})$ denotes the system output, and $\boldsymbol{x}\ (\boldsymbol{t})$ is the system input ***(3 marks)***

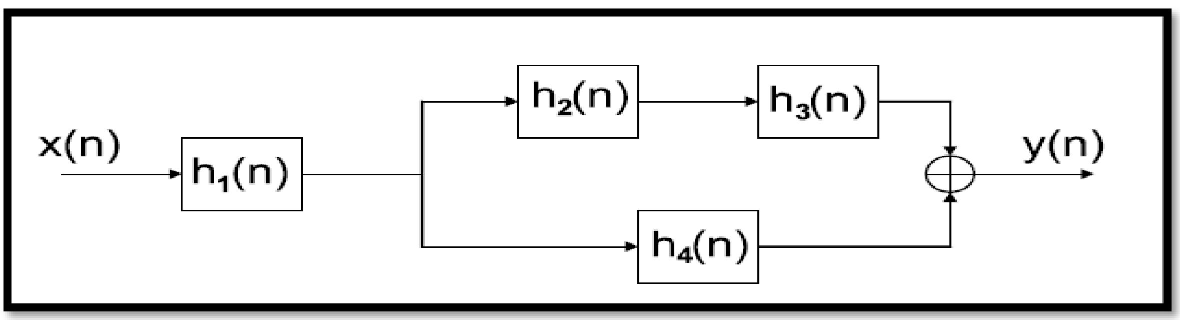
1) $\boldsymbol{y(t) = 3x(t)cos(t)}$

2) $\boldsymbol{y(t) = \int_{t}^{t+1} x(\lambda)d\lambda}$

Hint: Put √ if the system holds the property and × if not

system	Linear	Time-invariant	Causal
$\boldsymbol{y(t) = 3x(t)cos(t)}$			
$\boldsymbol{y(t) = \int_{t}^{t+1} x(\lambda)d\lambda}$			

b) Consider the interconnection of four LTI systems shown in the figure below. Find the **impulse response**, $h[n]$ of the **overall system** from the **properties** of **DT** convolution. ***(2 marks)***



Solution

Question 3 ***(5 marks)***

Calculate the convolution of the signal $\boldsymbol{x[n]}$ with the impulse response, $\boldsymbol{h[n]}$ (**using the equation of convolution by hand**) where:

$\boldsymbol{x[n] = \{3, 4, 5\}},$ $\quad\boldsymbol{x[n]}$ has only non-zero values at $\boldsymbol{n = 0, 1, 2}$

$\boldsymbol{h[n] = \{2, 1\}},$ $\quad\boldsymbol{h[n]}$ is not zero at $\boldsymbol{n = 0, 1}$

Solution

Question 4 ***(4 marks)***

Determine the **Fourier Series** representation (**trigonometric form**) for the function $\boldsymbol{f(x)}$, defined on $[\boldsymbol{-2, 2}]$, where

$$f(x) = \begin{cases} -1, & -2 \leq x \leq 0, \\ 2, & 0 < x \leq 2. \end{cases}$$

Solution

Question 5 ***(9 marks)***

a) Evaluate the **frequency-domain representations** of the following signal using **Fourier Transform**: ***(3 marks)***

$$x(t) = e^{-4|t|}$$

Solution

b) Use the **Fourier transform tables and properties** to obtain the Fourier transform of the following signal: ***(3 marks)***

$$\boxed{x(t) = \sin(2\pi t)e^{-t}u(t)}$$

Solution

c) Consider a **stable LTI** system characterized by the **differential equation** *(3 marks)*

$$\boxed{\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 3y(t) = \frac{dx(t)}{dt} + 2x(t)}$$

Find the **frequency response** $H(\omega)$ and **impulse response** $h(t)$ of the system.

Solution

Question 6 *(3 marks)*

Use the **definition** of the Laplace Transform; determine the Laplace transform of the following signal:

$$\boxed{x(t) = e^{at}u(t-k)}$$

Sketch the **pole-zero plot**. What is the condition on for the Fourier Transform to exist?

Solution

Question 7 ***(4 marks)***

Write a complete **MATLAB** program to

a) **Generate** and **plot** in the same figure each of the following **CT** signals:

$$x_1(t) = 5\, e^{-0.2t}\, sin\,(2\pi t), \qquad -5 \le t \le 10;$$

$$x_2(t) = e^{(-4\pi-0.5)t}\, u(t) \quad , \qquad -1 \le t \le 15.$$

b) Compute the **convolution** $y\,(t) = x_1(t) * x_2(t)$ and **plot** the result in the same figure.

Hints:

- Do not use the **"for" loops** in your code.
- Use **suitable** axis and titles in your code.

Solution

GOOD LUCK