Philadelphia University
Faculty of Engineering

Marking Scheme

Examination Paper

BSc CEE

Signals and Systems *(*650320+640543*)*

Second Exam First semester Date: 07/01/2020

Section 1

Weighting 20% of the module total

Lecturer: Dr. Qadri Hamarsheh

Coordinator: Dr. Qadri Hamarsheh

Internal Examiner: Dr. Saleh Saraireh

Marking Scheme
Signals and Systems (650320+640543)

The presented exam questions are organized to overcome course material through 4 questions.
The *all questions* are compulsory requested to be answered.

Marking Assignments

Question 1 This question is attributed with 5 marks if answered properly; the answers are as following:

1) For a discrete linear time-invariant system, the **system response** can be written in terms of convolution as

a)	$y[n]=h[n]*x[n]=\sum_{k=-\infty}^{\infty} h[k]x[k]$
b)	$y[n]=h[n]*x[n]=\sum_{k=-\infty}^{\infty} h[n+k]x[n-k]$
c)	$y[n]=h[n]*x[n]=\sum_{k=-\infty}^{\infty} h[k]x[n-k]$
d)	$y[n]=h[n]*x[n]=\sum_{k=-\infty}^{\infty} h[k]x[n+k]$

2) If $h1, h2$ and $h3$ are cascaded (**series connection**), and $h1 = u(t)$, $h2 = exp(t)$ and $h3 = sin(t)$, find the **overall impulse response**

a) $sin(t) * exp(t) * u(t)$
b) $sin(t) + exp(t) + u(t)$
c) $u(t) * sin(t)$
d) **all of the mentioned**

3) The linear time-invariant system with $h(t)=4e^{-2t}u(t)$

a) **Stable, causal, and memeoryless** **b)** **Stable, but not causal**
c) **Stable, causal, but has memory** **d)** **Not stable**

4) What is the equation $\mathbf{x(t)} = \sum_{k=-\infty}^{\infty} D_k e^{jk\omega t}$ called?

a) **Analysis equation**
b) **Synthesis equation**
c) **Frequency domain equation**
d) **Discrete equation**

5) Choose the condition from below that is **not** a part of **Dirichlet's conditions**

a)	**If it is continuous then there are a finite number of discontinuities in the period T**
b)	**It has a finite number of positive and negative maxima in the period T**
c)	**It has a finite average value over the period T**
d)	**It is a periodic signal**

Question 2: This question is attributed with 6 marks if answered properly,

a) *(3 marks)*

Solution

a) $h[n] = cos(\frac{\pi}{8} n)\{u[n] - u[n - 10]\}$

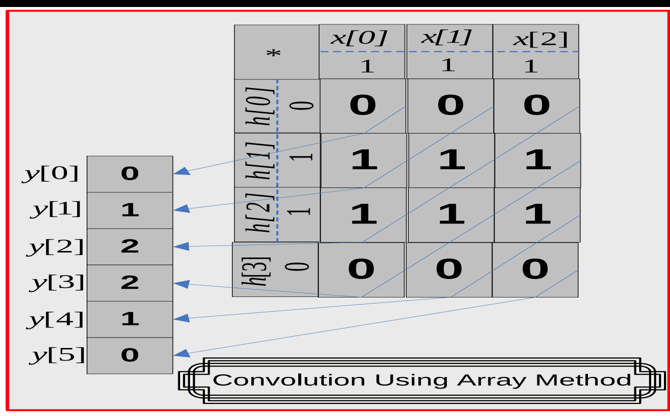
The system has memory, causal and stable

b) $h(t) = e^{-2t} u(t - 1)$

The system has memory, causal and stable

b) *(3 marks)*

Solution



Question 3: This question is attributed with 8 marks if answered properly,

a) *(2 marks) Bonus*

Solution

Given Signal $x(t) = \cos(2\pi t) + 4\sin(6\pi t)$

Period of cos(2πt) is $T_1 = 1$

Period of sin(6πt) is $T_2 = 1/3$

The Fundamental period x(t) is T = 1sec

Expressing x(t) as

$$x(t) = \frac{1}{2}[e^{j(2\pi t)} + e^{-j(2\pi t)}] + \frac{4}{2j}[e^{j6\pi} - e - j^{6\pi}]$$

$$= \frac{1}{2}e^{j2\pi} + \frac{1}{2}e^{-j2\pi} + \frac{2}{j}e^{j2\pi(3)t} - \frac{2}{j}e^{-j2\pi(3)t}$$

Fourier Series representation is

$$x(t) = \sum_{k=-\infty}^{\infty} X(k)e^{jk\omega_0 t}$$

Comparing with above equation

$$X(k) = \begin{cases} -\frac{2}{j} & k = -3 \\ \frac{1}{2} & k = -1 \\ \frac{1}{2} & k = 1 \\ \frac{2}{j} & k = +3 \\ 0 & otherwise \end{cases}$$

b) *(6 marks)*

Solution

Solution: Let $f(x) = \frac{a_0}{2} + \sum_{n=1} a_n \cos nx + \sum_{n=1} b_n \sin nx$ … (

Then Euler's constants a_0, a_n and b_n are given by

$$a_0 = \frac{1}{\pi}\int_{-\pi}^{\pi}(x - x^2)\,dx = \frac{1}{\pi}\left[\frac{x^2}{2} - \frac{x^3}{3}\right]_{-\pi}^{\pi} = -\frac{2\pi^2}{3}$$

$$a_n = \frac{1}{\pi}\int_{-\pi}^{\pi}(x - x^2)\cos nx\,dx = \frac{1}{\pi}\left[(x - x^2)\left(\frac{\sin nx}{n}\right) - (1 - 2x)\left(-\frac{\cos nx}{n^2}\right) + (-2)\left(-\frac{\sin nx}{n^3}\right)\right]_{-\pi}^{\pi}$$

$$= \frac{1}{\pi}\left[(1 - 2\pi)\frac{\cos n\pi}{n^2} - (1 + 2\pi)\frac{\cos n\pi}{n^2}\right] = \frac{-4(-1)^n}{n^2}$$

$$b_n = \frac{1}{\pi}\int_{-\pi}^{\pi}(x - x^2)\sin nx\,dx = \frac{1}{\pi}\left[(x - x^2)\left(-\frac{\cos nx}{n}\right) - (1 - 2x)\left(-\frac{\sin nx}{n^2}\right) + (-2)\left(\frac{\cos nx}{n^3}\right)\right]_{-\pi}^{\pi}$$

$$= \frac{1}{\pi}\left[-(\pi - \pi^2)\frac{\cos n\pi}{n} - 2\frac{\cos n\pi}{n^3} + (-\pi - \pi^2)\frac{\cos n\pi}{n} + 2\frac{\cos n\pi}{n^3}\right] = \frac{-2(-1)^n}{n}$$

Therefore the Fourier series for $f(x) = x - x^2$ is

$$f(x) = x - x^2 = -\frac{\pi^2}{3} - 4\sum_{n=1}^{\infty}\frac{(-1)^n}{n^2}\cos nx - 2\sum_{n=1}^{\infty}\frac{(-1)^n}{n}\sin nx$$

$$\therefore\quad x - x^2 = -\frac{\pi^2}{3} + 4\left[\frac{\cos x}{1^2} - \frac{\cos 2x}{2^2} + \frac{\cos 3x}{3^2} - \dots\dots\right] + 2\left[\frac{\sin x}{1} - \frac{\sin 2x}{2} + \frac{\sin 3x}{3} - \dots\dots\right]$$

Question 4: This question is attributed with 3 marks if answered properly,

Solution
kx = [-1 0 1]; % time indices where x is nonzero **x = [-1 1 2]; % Sample values for DT sequence x** **kh = [-1 0 1 2 3]; % time indices where y is nonzero** **h = [3 1 -2 3 -2]; % Sample values for DT sequence y** **y = conv(x, h); % Convolve x with h** **ky = kx(1)+kh(1):kx(length(kx))+kh(length(kh));** **% ky= time indices for y**