MACHAKOS UNIVERSITY

University Examinations for 2023/2024 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATIONA FOR

BACHELOR OF TECHNOLOGY IN TELECOMMUNICATION ENGINEERING

SPH 310/EEE410: SIGNAL PROCESSING/SIGNALS AND SYSTEMS

DATE: **TIME:**

INSTRUCTIONS

1. This paper consists of **FIVE** questions.
2. Answer **QUESTION ONE** and **ANY OTHER TWO** questions.

Question ONE (30Marks)

a) Define the following elementary signals using equations and diagrammatic illustrations as appropriate. For each case, give the continuous-time illustration only. (6marks)

   i. Unit impulse function

   ii. Sinusoidal signal

   iii. Unit step function

b) Explain what deterministic and random signals are. Give examples for each. (4marks)

c) Differentiate between energy and power signals. (4marks)

d) Give the trigonometric Fourier series defining equations. (4marks)

e) Given the differential equation below, determine y(t). (6marks)

$$y''(t) + y'(t) - 6y(t) = x'(t) + x(t)$$

Where:

$x(t) = e^{4t}u(t)$

f) Find the Fourier series coefficients for the signal below. (6marks)

$$x(t) = \begin{cases} 0 & -\frac{T}{2} \leq t < T_1 \\ 1 & -T_1 \leq t \leq T_1 \\ 0 & T_1 < t < \frac{T}{2} \end{cases}$$

where $T_1 \leq T$ and $x(t)$ is T-periodic

QUESTION 2

(a) Differentiate between even and odd signals. Use equations and sketches to illustrate. (4marks)

(b) Consider the signal whose Fourier transform is given below. Determine its inverse Fourier transform. (4marks)

$$X(j\omega) = 2\pi\delta(\omega - \omega_0)$$

(c) State Parseval's theorem for discrete time signals. Give the relevant mathematical formulation. (4marks)

(d) The impulse response of a continuous time system is given below. Determine its frequency response.
(4marks)

$$h(t) = \frac{1}{RC} e^{-t/RC} u(t)$$

(e) Find the Fourier transform of the signal given below.
(4marks)

$$x(t) = e^{-at}u(t), \quad \mathrm{Re}\{a\} > 0$$

QUESTION 3

(a) State the following Fourier series properties. (4marks)

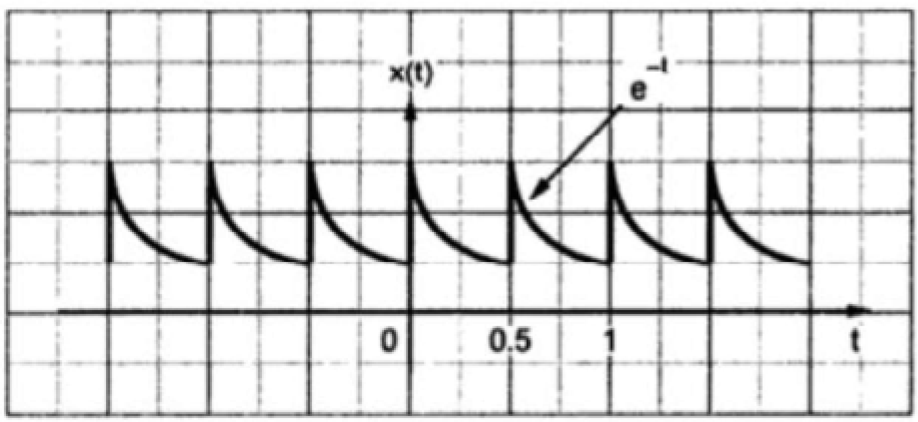
i. Linearity

ii. Time differentiation

iii. Multiplication or modulation theorem

iv. Frequency Shift

(b) Determine the trigonometric Fourier series for the periodic signal shown below. (8marks)



(c) For the Fourier transform for a given function to exist, the Dirichlet conditions ought to be satisfied. State the Dirichlet conditions. (4marks)

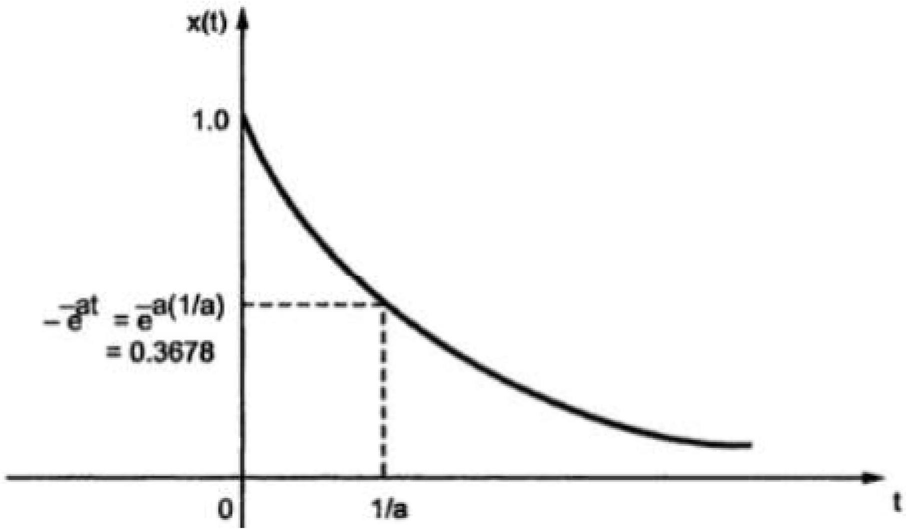
(d) Determine the laplace transform of the signal given below. (4marks)

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

QUESTION 4

(a) State the following Fourier transform properties.
(4marks)
i. Integration
ii. Duality
iii. Time scaling
iv. Convolution

(b) Find the Fourier transform of the signal shown below. (4marks)



(c) Differentiate between time variant and time invariant systems. (4marks)

(d) Consider an LTI system with the impulse response below

$$h[n] = \begin{cases} 1 & \text{if } 0 \leq n \leq 3, \\ 0 & \text{otherwise.} \end{cases}$$

Suppose the input signal is

$$x[n] = \begin{cases} 1 & \text{if } 0 \leq n \leq 3, \\ 0 & \text{otherwise.} \end{cases}$$

Determine the output of this system for *n* is less than 7.
(8marks)

QUESTION 5

(a) Differentiate between causal and non-causal systems.
(4marks)

(b) A causal LTI system has impulse response h(n), for which the z-transform is:

$$\mathbf{H(z) = (1+z^{-1})/(1-0.5z^{-1})(1+0.25z^{-1})}$$

Is the system stable? Explain.
(4marks)

(c) Determine whether the system described by the function below is causal and stable.
(4marks)

$$\mathbf{H(Z) = (1/1-0.5z^{-1})+(1/1-2z^{-1})}$$

With the region of convergence is given as:

$$\mathbf{|z| < 0.5}$$

(d) Find the step response of a system if the impulse response is given by:

$$h(n) = \delta(n-2) - \delta(n-1)$$

(4marks)

(e) Determine whether the system whose impulse response is given below is causal or non-causal.

(4marks)

$$\mathbf{h(t) = e^{-|t|}}$$