MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS

UNIVERSITY ORDINARY EXAMINATION

2023/2024 ACADEMIC YEAR

THIRD YEAR **SECOND** SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN EEE, BTECH, ORDINARY EXAM

EET 306 – SIGNALS AND SYSTEMS

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question one and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a. Differentiate with examples the following classes of signals.
   i. Continuous time and discrete time signals.
   ii. Deterministic and random signals. (2marks)

b. A continuous time signal $x_{(t)}$ is shown in figure 1. Sketch and label each of the following signals.

   Insert diagram………………..

   i. $x\ (t-2)$
   ii. $x(2t)$
   iii. $x(t/2)$
   iv. $x\ (t)$ (4marks)

c. A continuous-time signal $x(t)$is shown in figure 2. Sketch and label each of the following signals.

Insert diagram….

i. $x(t)U_{(1-t)}$
ii. $x(t)\ [\ U_{(t)} - U\ (t-1)]$
iii. $x(t)\ \delta\ (t - 3/2)$

d. The discrete time system shown in figure 3 is known as the unit delay element. Determine whether the system is;
   i. Memoryless
   ii. Causal
   iii. Linear
   iv. Time-invariant or
   v. Stable (8marks)

   Insert diagram

   Figure 3: Unit delay element.

e. The input $x(t)$ and the impulse response h(t) of a continuous LTI system are given by:

$$x(t) = U(t), h(t) = \ e^{-at}\ u(t) \propto > 0$$

   i. Sketch $x(t) and\ h(t)$
   ii. Compute the output y(t) (4marks)

SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

a. The continuous time system shown in figure 5 consist of two integrators and two scalars multipliers. Write a differential equation that relates the output $y(t)$ and the input $x(t)$.

(5marks)

b. Consider a continuous time LTI system with the input output relation given by $y(t) = \int_{-\infty}^{t} e -^{(t-z)}\ x\,(z)d$……..

i. Find the impulse response h(t) of the system.

ii. Show that the complex exponential function e^{st} is an Eigen function of the system.

iii. Find the eigenvalue of the system corresponding too e^{st} by using the impulse response h(t) obtained in part (i). (8marks)

c. Consider the continuous time signal $x(t)$ given as; $x(t) = 3\cos(100\pi t)$

i. Determine the minimum sampling rate required to avoid liaising.

ii. Suppose that the signal is sampled at the rate F_s = 200Hz, what is the discrete time signal obtained after sampling.

iii. Suppose that the signal is sampled at the rate F_s = 75Hz. What is the discrete time signal obtained after sampling?

iv. What is the frequency $0 > f < {}^{fs}/_{2}$ of ….. that yields samples identical to those obtained in part (iii). (7marks)

QUESTION THREE (20 MARKS)

a. Consider an ideal low pass filter with the frequency response.
Insert…………………

The input to this filter is

$$x_{(t)} = \frac{\sin at}{\pi t}$$

i. Find the output $y(t)$ for a $a < w_c$

ii. Find the output $y(t)$ for a $a > w_c$

iii. In which case does the output suffer distortion? (4marks)

b. Find the fourier transform of the following signals $x(t)$
Inser………………………………..

(8marks)

c. Consider the system shown in figure 6. Determine whether it is;

Insert diagram………

i. Memory less
ii. Causal
iii. Linear
iv. Time invariant
v. Stable (8marks)

QUESTION FOUR (20 MARKS)

a. .
   i. State the NY Quist Sampling Theorem. (1mark)
   ii. Describe the sampling process of a continuous time signal $x(t)$ and hence show that the sampled signal $x_s\ (t)$ can be given as;
   Insert….

   State the desired relationship between sampled signal spectrum $x_{s\ (f)}$ and the continuous signal spectrum$x_{c\ (f)}$. Name all the variables. (5marks)

b. We want to digitize and store a signal on a CD and then reconstruct it at a later time as shown in figure 7. Let the signal $x_{(t)}$ be;

$$x_{(t)} = 2\cos(500\pi t) - 3\sin(1000\pi t) + \cos(1500\pi t)$$

   Let the sampling frequency be $f_s = 2kH_z$.
   i. Determine the continuous time signal $y(t)$ after the reconstruction.
   ii. Notice that $y(t)$ is not exactly equal to $x_{(t)}$ exactly from its samples ……….

Insert diagram………

Figure 7.

c. Consider a continuous – time LTI system described:

$$\frac{dy(t)}{dt} + 2y(t) = x(t)$$

Using the Fourier transform, find the output $y(t)$ of the following input signals.

i. $x(t) = e^{-t}\,U_{(t)}$
ii. $x(t) = u(t)$ (8marks)