CHUKA  **UNIVERSITY**

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE

EENG 482: SIGNAL AND SYSTEMS EXAM

STREAMS: **TIME: 2 HOURS**

DAY/DATE: TUESDAY 19/12/2023 **2.30 P.M. – 4.30 P.M.**

INSTRUCTIONS

Question 1

a) Differentiate between an invertible and non-invertible system? **(4 marks)**

b) Using z-transform, show that the system

$$y(t) = \sum_{k=-\infty}^{n} x(k)$$

is invertible. **(5 marks)**

c) Given a signal $f(t) = 3t^2 + 2t + 1$, which is multiplied by 2 unit delayed version of impulse and integrated over a period of $-\infty$ to ∞ . Calculate the resultant. **(3 marks)**

d) State at least four applications of convolution. **(5 Marks)**

e) State an important aspect of the unit impulse function in regard to linear combination of delayed impulses of signals. **(3 Marks)**

f) Explain the main reasons for carrying our signal processing using Fourier Transform. **(3 Marks)**

g) Define the meaning of linearity or linear system in signals. **(3 Marks)**

h) Differentiate between sampling and quantization as two steps involved in the analog-to-digital conversion. **(4 Marks)**

Question 2

a) An impulse response of a system is given by $h[n] = \begin{cases} \alpha^n & 0 \le n \le 6 \\ 0 & otherwise \end{cases}$ and its input signal is $x[n] = \begin{cases} 1 & 0 \le n \le 4 \\ 0 & otherwise \end{cases}$

i) Sketch the figure of the impulse response and the input signal of this system. **(4 Marks)**

ii) Compute the response of the LTI system described by the impulse response and the input signal. **(6 marks)**

iii) Sketch the output response of the LTI system. **(2 Marks)**

b) State and explain three properties of LTI systems. **(8 marks)**

Question 3

a) Consider a sinusoidal signal

$$x(t) = 3\cos(1000\pi t + 0.1\pi)$$

and let us sample it at a frequency $F_s = 2kHz$. **(12 marks)**

i) Determine and expression for the sampled sequence $x[n] = x(nT_s)$ and determine its Discrete Time Fourier Transform $X(\omega) = DTFT\{x[n]\}$;

ii) Determine $X(F) = FT\{x(t\};;$

iii) Recompute $X(\omega)$ from the $X(F)$ and verify that you obtain the same expression as in a).

b) Let $y[n]$ denote the convolution of $h[n]$ and $g[n]$, where h[n] =$\left(\frac{1}{2}\right)^n u[n]$ is causal sequence. If $y[0] = 1$ and $y[1] = \frac{1}{2}$, find the value of $g[1]$. **(8 marks)**

Question 4

a) A discrete-time LTI system is described by the following difference equation

$$y(n) = \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) + x(n-1)$$

Also, it is given that $y(-1) = 0$ and $x(-2) = -1$. Use the inverse z-transform to find the natural response of the system. **(10 marks)**

b) In pairs, discuss at least five classification of signals. Use mathematical equations or graphs to show the differences, where applicable. **(10 marks)**

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