UNIVERSITY OF BUEA
FACULTY OF ENGINEERING AND TECHNOLOGY
SECOND SEMESTER EXAMINATIONS

MONTH: July
YEAR: 2014
DATE: 14/07/14
TIME ALLOWED: 3 HOURS

COURSE INSTRUCTOR: SONE EKONDE
COURSE CODE & NUMBER: CEF 310
COURSE TITLE: Digital Signal Processing
TIME: 08.00 – 11.00
CREDIT VALUE: 4

INSTRUCTION: Answer ANY THREE questions. Each question carries 25 marks

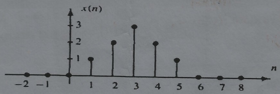
QUESTION 1

A) A second-order recursive system is described by the difference equation

$$y(n) = 3/4\, y(n-1) - 1/8\, y(n-2) + x(n) - x(n-1)$$

i) Represent the system with a block diagram
ii) Find the unit sample response h(n) of this system
iii) Find the system's response to the input x(n) represented as follows

$\left[-2\left(\frac{1}{2}\right)^n + 3\left(\frac{1}{4}\right)^n\right]u($



(15 marks)

B) Given the sequence $x(n) = (6-n)[u(n) - u(n-6)]$ make a sketch of
i) $y_1(n) = x(4-n)$
ii) $y_2(n) = x(2n-3)$

(6 marks)

C) Find the convolution of the two finite-length sequences:
$x(n) = 0.5n\,[u(n) - u(n-6)]$
$h(n) = 2\sin(n\pi/2)\,[u(n+3) - u(n-4)]$

(4 marks)

QUESTION 2

A) Define the Discrete-time Fourier Transform. Use this definition to determine the frequency response of a filter given by the following difference equation
$y[n] = 0.5\, y[n-1] - 0.25\, y[n-2] + 0.5\, x[n] + 0.5\, x[n-2]$ **(7 marks)**

B) Determine whether or not the signals below are periodic and, for each signal that is periodic, determine the fundamental period

i) $x(n) = \cos(0.125\,\pi n)$ ii) $x(n) = R_e\left\{e^{jn\pi/12}\right\} + I_m\left\{e^{jn\pi/18}\right\}$

(6 marks)

C) Find the even and odd parts of the following signals
i) $x(n) = u(n)$ ii) $x(n) = \alpha^n u(n)$

(6 marks)

D) Find the z-transform of each of the following sequences;
i) $x(n) = \cos(n\omega_0)\, u(n)$
ii) $x(n) = n\,(1/2)^n\, u(n-2)$

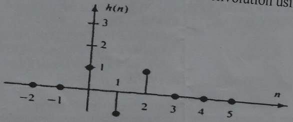
(6 marks)

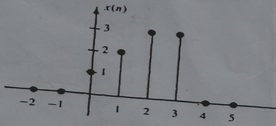
QUESTION 3

A) Perform
i) Four-point circular convolution and 1, 4, 2, 2
ii) Four-point linear convolution 1, 5, 3, 3

$\frac{\frac{5}{8}z^{-1} - \frac{1}{2}}{\left(1-\frac{1}{2}z^{-1}\right)^2}$

of the two sequences h[n] and x[n] shown below. Comment on the results by highlighting the computation of linear convolution using the DFT





(12 marks)

B) We would like to linearly convolve a 3000-point sequence with a linear shift-invariant filter whose unit sample response is 60 point long. The filter is to be implemented using 128-point DFTs and inverse DFTs. How many DTTs are needed if

i) Overlap-add algorithms is used

ii) Fast Fourier Transform (FFT) algorithm is used

(8 marks)

C) Given the DFT sequence X(k) for $0 \leq k \leq 3$
where $X(0) = 10$, $X(1) = -2 + j2$, $X(2) = -2$, $X(3) = -2 - j2$.
Evaluate its inverse DFT x[n] using the decimation-in-frequency method.

(5 marks)

QUESTION 4

A) i) State the sampling theorem.

ii) Determine the minimum sampling frequency for the bandpass signals, $x_a(t)$ which is real and with $X_a(f)$ nonzero only for $9\text{kHz} < |f| < 12\text{ kHz}$

iii) The Discrete-time Fourier transform of sampled signal, x(t) is given as

$$X(e^{j\omega}) = (1/_T) \sum_{k=-\infty}^{\infty} X^a\,[(\omega + 2\pi k)/T]$$

where $X^a(\omega)$ is the Fourier transform of bandlimited signal, x(t) and T is the sampling frequency. Sketch the waveform of $X(e^{j\omega})$ if sampling frequency is less than the Nyquist frequency.

(10 marks)

B) The periodic signal $x(t) = \sin 2\pi t$ is sampled using the rate $f_s = 4\text{Hz}$.

i) Compute the spectrum $\tilde{x}[n]$ using the samples in one period

ii) Plot the two-sided amplitude spectrum $|\tilde{x}[n]|$ over the range from -2 to 2 Hz

(5 marks)

C) Consider the discrete-time sequence $x(n) = \cos(n\pi / 8)$. Find two different continuous-time signals that would produce this sequence when sampled at a frequency of $f_s = 10$ KHz.

(5 marks)

D) Consider the finite-length sequence, $x[n] = [1, 1, 1, 1, 1, 1]$ and let X(z) be its z-transform. If the sample X(z) is sampled at $z_k = exp\left(j\,\frac{2\pi}{4}\,k\right)$ for k= 0, 1, 2, 3, a set of DFT coefficients X(k) is obtained. Find the sequence, y(n), that has a four-point DFT equal to these samples.

(5 marks)
