FNU FIJI NATIONAL UNIVERSITY

COLLEGE OF ENGINEERING, SCIENCE AND TECHNOLOGY

School of Electrical & Electronics Engineering

Bachelor of Engineering (Electrical & Electronics)

EEE787 – Fundamentals of Digital Signal Processing

FINAL EXAMINATION

Semester 1, 2015

Date: As per Exam Time Table

Time: As per Exam Time Table (3 hours)

Venue: As per Exam Timetable

Instructions to Students

1. You are allowed an extra ten (10) minutes of reading time during which you are NOT allowed to write.
2. Attempt ALL questions in this examination booklet
3. Write your answers in the answer booklet provided.
4. Write your Student ID number on each page used.
5. Begin each Section on a fresh page and use both sides of the answer sheet.
6. You may use calculators provided they are non-programmable.
7. Clearly number the questions in your answer paper in their correct sequence and write legibly. Show all working.
8. Attach any extra sheets used to your answer booklet securely with the string provided.

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Final Examination

Question 1: **[10 marks]**

Real time signals are mostly acquired in analog form from sensors and converted to digital signal for processing. With the aid of block diagrams, explain digital signal processing system and the processes involved in converting signals from analog to digital. Also state the sampling theorem, quantization error, and functions of each of the blocks.

Question 2: **[8 marks]**

A digital communication link carries binary-coded words representing samples of an input signal $x_a(t) = 3.2\cos 860\pi t - 1.5\sin 910\pi t$. The link is operated at 8, 500 bits/s and each input sample is quantized into 1024 different voltage levels.

a) Determine the sampling frequency and the folding frequency. [2 marks]

b) Determine the Nyquist rate for the signal. [1 mark]

c) Determine the resulting discrete-time signal $x(n)$ and the frequencies present? [4 marks]

d) What is the resolution? [1 mark]

Question 3: **[7 marks]**

Given the following input signal:

$$x(n) = \begin{cases} |-2n+5|, & -3 \le n \le 3 \\ 0, & otherwise \end{cases}$$

a) Represent the signal using sequence representation. [2 marks]

b) Determine the response of the system:

$$y(n) = \sum_{-\infty}^{+\infty} x(k) = x(n-3) + x(n-2) + x(n-1) + x(n) + x(n+1) + x(n+2) + ... \quad \text{[5 marks]}$$

Question 4: **[8 marks]**

Using the functions given below, show that convolution in time domain is same as multiplication in frequency domain. $x(n) = \{-4, 2, 1\}$, $h(n) = \{-2, \underset{\uparrow}{1}, 3, 1\}$

Please Turn Over

Question 5: **[7 marks]**

Given the sequences:

$$x(n) = \{...,0,0,-2,3,\underset{\uparrow}{7},1,0,0,...\} \text{ and } y(n) = \{...,0,0,-2,1,-\underset{\uparrow}{2},4,-3,0,0,...\}$$

Determine the normalized cross-correlation sequence $\rho_{xy}(l)$.

Question 6: **[6 marks]**

Determine the system function and the unit sample response of the system described by the difference equation $0.5y(n) = 2y(n-1) + y(n) - 1.5x(n-1) + 0.5x(n)$

Question 7: **[8 marks]**

a) Determine the z-transform and ROC of the signal $x(n) = [2(0.9^n) - 3(0.32^n)]u(n)$. [4 marks]

b) Determine the one-sided z-transform of the signal $x_1(n) = x(n+2)$ given $x(n) = 0.3^n u(n)$.

[4 marks]

Question 8: **[8 marks]**

A linear time-invariant system is characterized by the system function $H(z) = \frac{-2}{1+1.2z^{-1}} + \frac{5}{1-2z^{-1}}$.

Specify the ROC of $H(z)$ and determine $h(n)$ for the following conditions:

a) The system is stable. Is this system causal, anticausal or non-causal? [4 marks]

b) The system is causal. Is this system stable? [4 marks]

Question 9: **[24 marks]**

Consider the FIR filter $y(n) = 0.75y(n-1) + 0.5x(n)$.

a) Compute and sketch its magnitude and phase response for $-\pi \le w \le \pi$. [9 marks]

b) Determine the transient and steady state response of the system when the input signal is $x(n) = \sin(3\pi n/4)\,u(n)$ [15 marks]

Please Turn Over

Question 10: **[14 marks]**

Design a two-pole bandpass filter that has the center of its passband at $w = \pi/2$, zero in its frequency response characteristic at $w = 0$ and $w = \pi$, and a magnitude response of $1/\sqrt{2}$ at $w = \pi/5$.

THE END

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Please find attached the z-transform table.

Signal, $x(n)$	z-Transform, $X(z)$	ROC
$\delta(n)$	1	All z
$u(n)$	$\frac{1}{1-z^{-1}}$	$\lvert z\rvert > 1$
$-a^n u(-n-1)$	$\frac{1}{1-az^{-1}}$	$\lvert z\rvert < \lvert a\rvert$
$-na^n u(-n-1)$	$\frac{az^{-1}}{(1-az^{-1})^2}$	$\lvert z\rvert < \lvert a\rvert$
$(\cos w_0 n)\,u(n)$	$\frac{1-z^{-1}\cos w_0}{1-2z^{-1}\cos w_0 + z^{-2}}$	$\lvert z\rvert > 1$
$(\sin w_0 n)\,u(n)$	$\frac{z^{-1}\sin w_0}{1-2z^{-1}\cos w_0 + z^{-2}}$	$\lvert z\rvert > 1$

Final Examination - Solution

Solution sheet for graph of Question 9(a). Attach to your answer sheet.