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, 2016

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: **[7 marks]**

a) With the aid of block diagrams, briefly explain the steps of a digital signal processing (DSP) system. [4 marks]

b) Clearly state sampling theorem and quantization error. [3 marks]

Question 2: **[6 marks]**

Consider the analog signal $x_a(t) = 3\cos 2860\pi t - 1.5\sin 6910\pi t + 10\cos 10000\pi t$.

a) Determine the Nyquist rate for the signal. [2 marks]

b) Determine the resulting discrete-time signal $x(n)$ and the frequencies present if the signal is sampled at 6000 Hz? [4 marks]

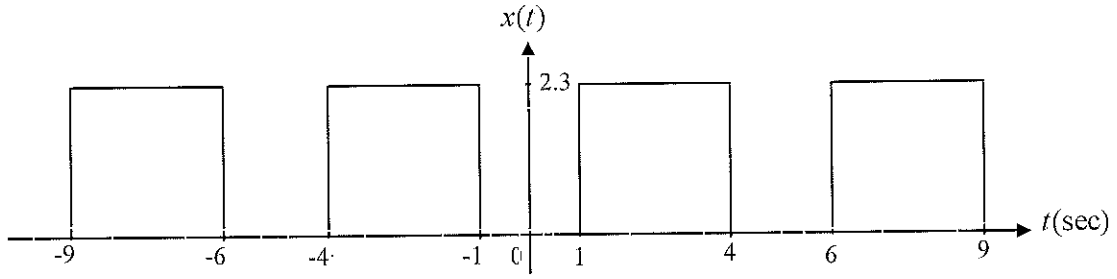
Question 3: **[7 marks]**

Given the input signal $x(n) = \left(\frac{1}{2}\right)^n u(n)$, determine the response of the system $h(n) = \left(\frac{1}{5}\right)^n u(n)$.

Question 4: **[9 marks]**

a) Determine the power of a unit step sequence. [3 marks]

b) Determine the power density spectrum of the rectangular pulse train shown below. [6 marks]



Question 5: **[9 marks]**

a) Determine the cross-correlation sequence $r_{xy}(l)$. [5 marks]

$x(n) = \{...,0,0,-2,3,\underset{\uparrow}{7},4,0,0,...\}$ and $y(n) = \{...,0,0,-1,\underset{\uparrow}{2},-4,3,5,0,0,...\}$

b) Compute convolution of the sequences $x(n) = \{2,\underset{\uparrow}{-5},3\}$ and $y(n) = \{4,0,-6\}$ using multiplication in frequency domain method. [4 marks]

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Question 6: **[4 marks]**

Using the basic building blocks, sketch the block diagram representation of the discrete-time system $0.4y(n)=1.2y(n-2)+0.17x(n)+2.35x(n+1)-0.72y(n-1)$, where $x(n)$ is the input and $y(n)$ is the output of the system.

Question 7: **[13 marks]**

a) Using the differentiation in z-domain rule, find the z-transform of $2.73n\,(0.87)^n u(n)$. [4 marks]

b) Determine the step response of the system $y(n)=0.46y(n+1)+1.93x(n)$ when the initial condition is y(0) = -1. [9 marks]

Question 8: **[7 marks]**

A linear time-invariant system is characterized by the system function $H(z)=\frac{5}{1+0.2z^{-1}}-\frac{2}{1-1.4z^{-1}}$. 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? [3 marks]
b) The system is causal. Is this system stable? [4 marks]

Question 9: **[24 marks]**

Consider the FIR filter $y(n)=0.63y(n+1)+0.15x(n)$.

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 $x(n)=2\cos(\pi n/4)\,u(n)$ [15 marks]

Question 10: **[14 marks]**

Using the Kaiser window, design a bandpass digital filter with the following specifications:

f_s = 100 Hz, f_{sa} = 4 Hz, f_{pa} = 7 kHz, f_{pb} = 30 kHz, f_{sb} = 32 kHz, A_{pass} = 0.15 dB, A_{stop} = 60 dB.

THE END

ALL THE BEST FOR THE EXAMINATION

Please find attached the z-transform table and Kaiser Window equations on the next page.

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

Kaiser Window: $w(n)=\dfrac{I_0(\alpha\sqrt{n(2M-n)}/M)}{I_0(\alpha)}$

Shape parameter $\alpha=\begin{cases}0.1102(A-8.7), & \text{if } A\geq 50\\ 0.5842(A-21)^{0.4}+0.07886(A-21), & \text{if } 21<A<50\\ 0, & \text{if } A\leq 21\end{cases}$

Factor $D=\begin{cases}\dfrac{A-7.95}{14.36}, & \text{if } A>21\\ 0.922, & \text{if } A\leq 21\end{cases}$

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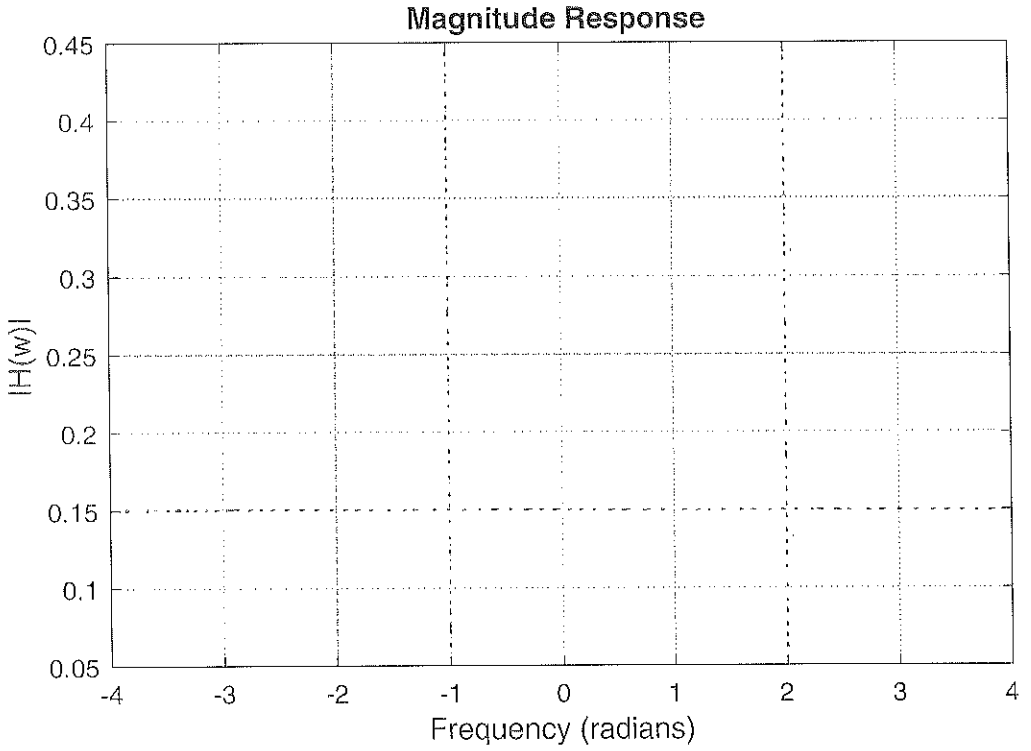
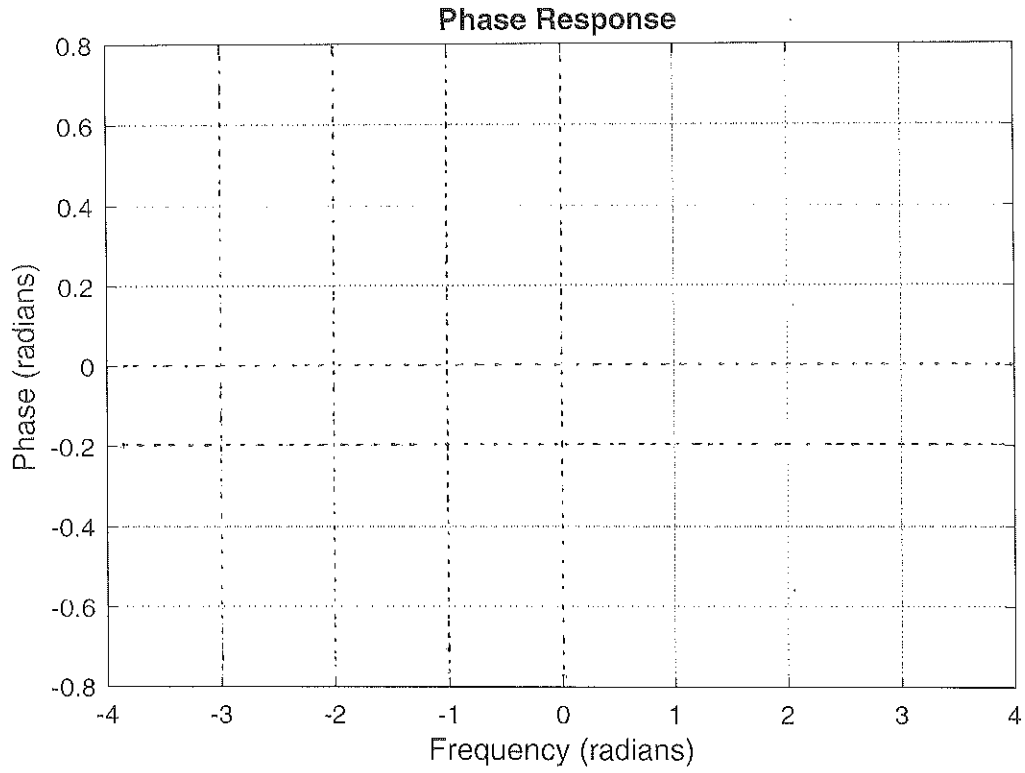
Final Examination - Solution

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





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