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, 2017

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.

****

Question 1 **[8 marks]**

With the aid of block diagrams, explain in detail how an analog signal is converted into a digital signal. Explain all the processes that are involved.

Question 2 **[8 marks]**

A digital communication link carries binary-coded words representing samples of an input signal $x_a(t) = 2.7\cos 752\pi t + 0.59\sin 824\pi t$. The link is operated at 8, 840 bits/s and each input sample is quantized into 4096 different voltage levels.

a) Determine the sampling frequency. [2 marks]

b) Determine the Nyquist rate. [2 marks]

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

Question 3 **[12 marks]**

Given the signal $x(n) = \begin{cases} 2|n|-4, & -3 \le n < 3 \\ 0, & otherwise \end{cases}$

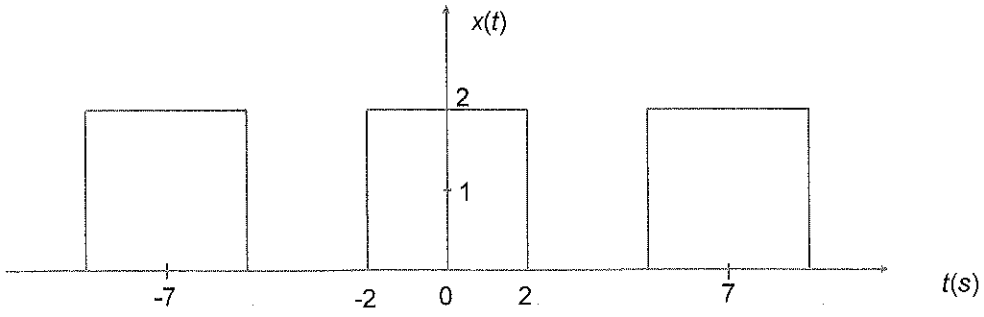
a) Represent $x(n)$ using sequence representation. [2 marks]

b) $y(n) = x(n+3) + x(n+1) + x(n-1)$ [5 marks]

c) Determine the normalized auto-correlation sequence $\rho_{xx}(l)$. [5 marks]

Question 4 **[8 marks]**

Determine the power density spectrum of the rectangular pulse train shown below.



Please Turn Over

Question 5 **[7 marks]**

Compute the linear convolution of the sequences $x(n)=\{1,2,\underset{\uparrow}{0},-2,1\}$ and $h(n)=\{-3,0,1,\underset{\uparrow}{-5},4\}$, that is $y(n)=x(n)*\mathrm{h(n)}$.

Question 6 **[13 marks]**

Refer to the difference equation $1.31y(n)=y(n-1)+2.15y(n)-3.89x(n)$ to answer the following questions:

a) Using the basic building blocks, sketch the block diagram representation of this discrete-time system, where $x(n)$ is the input and $y(n)$ is the output of the system. [4 marks]

b) Determine the step response of the system when the initial condition is y(-1) = 2. [9 marks]

Question 7: **[6 marks]**

A linear time-invariant system is characterized by the system function $H(z)=\frac{2}{1-0.87z^{-1}}-\frac{1.5}{1+2.38z^{-1}}$. Specify the ROC of $H(z)$ and determine $h(n)$ for the following conditions:

a) The system is stable. Is this system causal, anti-causal or non-causal? [3 marks]

b) The system is anticausal. Is this system stable (state your reason)? [3 marks]

Question 8: **[24 marks]**

Consider the FIR filter $y(n)=0.68y(n-1)+0.47x(n)$.

a) Compute and sketch its magnitude and phase response for $-2\pi \le w \le 2\pi$. (*Note: Plot the responses in the solution sheet provided*). [9 marks]

b) Determine the transient and steady state response of the system when the input signal is $x(n)=\sin(2\pi n/3)\,u(n)$ [15 marks]

Question 9: **[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 $1/\sqrt{5}$ at $w=4\pi/7$.

Please Turn Over

Given below is the z-transform table.

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

Equations:

$$Z^+\{x(n-k)\}=z^{-k}\left[X^+(z)+\sum_{n=1}^{k}x(-n)z^n\right]$$

$$Z^+\{x(n+k)\}=z^{k}\left[X^+(z)-\sum_{n=0}^{k-1}x(n)z^{-n}\right]$$

THE END

ALL THE BEST FOR THE EXAMINATION

Solution sheet for graph of Question 8(a). To be attached to your answer booklet.