PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination: Semester I — Academic Year: 2009
Date: 29 July 2009 — Time: 13:30-16:30
Subject: 241-571 Digital Signal Processing — Room: หัวหุ่นยนต์

Instructions:

This exam has 7 problems, 11 pages, and 63 points. Answer all questions on the exam sheets. You may use the back of the pages for scratch work. This exam is closed book and closed notes. Use of a calculator is permitted. You may consult one A4 sheet of notes (two sides).

Name:_____ Student code:_____

1 (12 pts) _____ 2 (10 pts) _____

3 (6 pts) _____ 4 (10 pts) _____

5 (10 pts) _____ 6 (10 pts) _____

7 (5 pts) _____

TOTAL _____

ทุจริตในการสอบ โทษขั้นต่ำคือ
ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

1. Given the following systems:

System 1: $T(x[n]) = x[n] + 0.2^n x[n] + u[n-1]$

System 2: $T(x[n]) = x[n+1]\, x[n-1]$

System 3: $T(x[n]) = x[n-1] + x[n] + n$

a) Which system(s) is(are) linear? (3 points)

b) Which system(s) is(are) causal? (3 points)

c) Which system(s) is(are) BIBO stable? (3 points)

d) Which system(s) is(are) time-invariant? (3 points)

Notes: Please show a short proof for each of your answers.

2. Consider the linear, time-invariant, discrete time system defined by the difference equation

$$y[n]-0.5y[n-1]+0.7y[n-2]=x[n]$$

a) Determine the frequency response of the system. (3 points)

b) From the frequency response function obtained in a), sketch the magnitude and phase response of the system. (7 points)

3. Sketch the convolution result of the following pairs of sequences (Please also label your sketch)

a) $(u[n+1]-u[n-2])*(\delta[n]+0.5\delta[n-1]-\delta[n-3])$ (3 points)

b) $w[n]*v[n]$, where $w[n]=\begin{cases}0.5^n & 0\le n\le 3\\ 0 & elsewhere\end{cases}$ and $v[n]=\begin{cases}n & |n|\le 2\\ 0 & elsewhere\end{cases}$ (3 points)

4. Compute the Discrete Time Fourier Transform of the sequence, $x[n] = \sum_{k=-\infty}^{\infty} \delta[n-k]$.

(10 points)

5. Short answers:
   a) Find the frequency response $H(e^{j\omega})$ of the linear time invariant system whose input and output satisfy the difference equation

$$y[n]+0.3y[n-1]+0.2y[n-2]+0.9y[n-4]=0.5x[n]+1.2x[n-2]+x[n-3]$$

(3 points)

b) Write the difference equation that characterizes a system whose frequency response is

$$H(e^{j\omega}) = \frac{1 - 0.3e^{-j2\omega} + 0.1e^{-j3\omega}}{1 + 0.5e^{-j2\omega} + 0.2e^{-j3\omega}}$$

(3 points)

c) Determine the frequency response of the inverse system of the following system

$$y[n] + y[n-1] = 0.1x[n] + 0.2x[n-1] + x[n-2]$$

(4 points)

6. The continuous-time signal $x_a(t) = 5\sin(40\pi t) - 2\cos(48\pi t)$ is sampled at a 100 Hz rate, generating the sequence $x[n]$. Determine the exact expression of $x[n]$. (10 points)

7. Sketch the poles and zeros of a 5^{th} order continuous-time butterworth lowpass filter whose cutoff frequency is at 32 radians/sec (5 points)

-- End of Exam --