มหาวิทยาลัยสงขลานครินทร์
คณะวิศวกรรมศาสตร์

PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination: Semester I
Date: 1 August 2012
Subject: 242-671 Digital Signal Processing

Academic Year: 2012
Time: 9:00-12:00
Room: S102

Instructions:

This exam has 7 problems, 13 pages, and 76 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 (10 pts) _____ 2 (10 pts) _____

3 (10 pts) _____ 4 (15 pts) _____

5 (6 pts) _____ 6 (15 pts) _____

7 (10 pts) _____

TOTAL _____

ทุจริตในการสอบ โทษขั้นต่ำคือ
ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

1. Give an example of a 2^{nd} order, causal LTI system and prove that it is causal, linear and time invariance. (10 points)

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

$$y[n] = x[n] - 0.9x[n-1]$$

a) Determine the frequency response of the system. (2 points)

b) From the frequency response function obtained in a), determine the magnitude response and phase response (in closed-form expressions). (4 points)

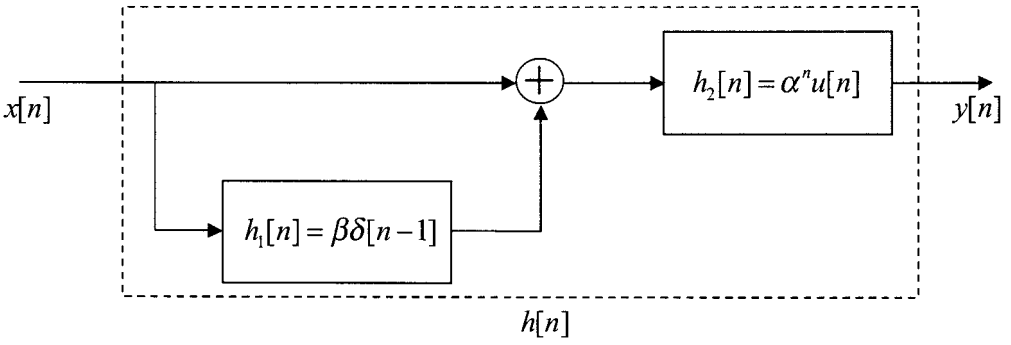
c) Plot the magnitude and phase response of the system at $\omega = 0, 0.1\pi, 0.2\pi, 0.3\pi$,...,$0.8\pi, 0.9\pi, \pi$,. (4 points)

3. Sketch the convolution sum of $w[n] * v[n]$ using the graphic method and also sketch your label. (10 points)

where $$w[n] = \begin{cases} 0.5^n & 0 \le n \le 3 \\ 0 & elsewhere \end{cases}$$

and $$v[n] = \delta[n] - \delta[n-1] + 2\delta[n-2]$$

4. Consider the following system



a) Find the impulse response $h[n]$ of the overall system (5 points)
b) Find the frequency response of the overall system (5 points)
c) Specify a difference equation that relates the output $y[n]$ to the input $x[n]$ (5 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

$$y[n]+0.1y[n-1]+0.2y[n-2]-0.3y[n-4]=x[n]-1.2x[n-2]+x[n-3]$$

(2 points)

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

$$H(e^{j\omega}) = \frac{1 - 0.3e^{-j2\omega} + 0.4e^{-j3\omega}}{1 - 0.1e^{-j2\omega} - 0.9e^{-j3\omega}}$$ (2 points)

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

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

6. Suppose $x_a(t)$ is a continuous-time signal and its magnitude response is

$$|H(j\Omega)| = \begin{cases} 0 & \Omega < -50Hz \\ \frac{\Omega}{50} + 1 & -50Hz \le \Omega < 0Hz \\ 1 - \frac{\Omega}{50} & 0Hz \le \Omega \le 50Hz \\ 0 & \Omega > 50Hz \end{cases}$$

If $x_a(t)$ is sampled at 100 Hz generating the sequence $x[n]$.

a) Sketch the magnitude response of the DTFT of $x[n]$. (10 points)

b) If $x[n]$ is up-sampled by a factor of 3.0, sketch the magnitude response of the DTFT of the sampled version of $x[n]$. (5 points)

7. Prove that the impulse response of a causal LTI system described by the difference equation

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

is

$$h[n] = h[n-1] + h[n-2], \quad n \geq 2,$$

with $h[0] = 0$ and $h[1] = 1$. (10 points)