PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Examination: Semester I	Academic Year: 2006
Date: .2. October 2006	Time: 9:00-12:00
Subject: 240-552 Digital Signal Processing	Room: R300

Instructions:

This exam has 5 problems, 8 pages and 105 points. Please show all your work for full credit. You may use the back of the pages for scratch work. This exam is closed book and closed note. You are allowed to bring in a calculator and one A4 sheet of notes.

Name:_____ Student code:_____

1 (10 pts) _____	4 (40 pts) _____
2 (30 pts) _____	5 (10 pts) _____
3 (15 pts) _____	
	TOTAL _____

"ทุจริตในการสอบ โทษขั้นต่ำ คือ พักการเรียน 1 ภาคการศึกษา และปรับตกในรายวิชาที่ทุจริต"

1. Sketch the magnitude response of the following systems: (10 points)

System I $H(z) = \dfrac{1}{1+0.5z^{-1}} + \dfrac{1}{1-(0.4+0.8j)z^{-1}} \dfrac{1}{1-(0.4-0.8j)z^{-1}}$

System II $H(z) = \dfrac{1-z^{-1}}{(1+(0.7-j0.5)z^{-1})(1+(0.7-j0.5)z^{-1})}$

2. Design a discrete-time Butterworth low-pass filter with the following specifications:

Passband frequency	0.3π rad./sec.
Stopband frequency	0.5π rad./sec.
Max. passband attenuation	2 dB
Min. stopband attenuation	20 dB
DC gain	1.5

2.1 Sketch (in s-plane) poles and zeros of the filter (10 points)

2.2 Determine poles and zeros of the discrete-time filter, assuming that the impulse invariance method was used. (10 points)

2.3 Determine poles and zeros of the discrete-time filter, assuming that the bilinear transform method was used. (10 points)

3. Short answers:

a) The filter design techniques of impulse invariance and the bilinear transform each have some advantages. List advantages that each technique has over the other. (5 points)

b) A discrete-time system is described by the following difference equation

$$y[n] = x[n] - 0.2\,x[n-1]$$

where $x[n]$ is the input sequence and $y[n]$ is the output sequence. Is this system a low-pass or high-pass filter? Justify your answer. (10 points)

4. Suppose we have two 4-point sequences x[n] and h[n] as follows:

$$x[n] = \{1, 0, -1, 0\}$$
$$h[n] = \{1, 0.5, 0.25, 0.125\}$$

4.1 Calculate the 4-point DFT X[k]. (10 points)
4.2 Calculate the 4-point DFT H[k]. (10 points)
4.3 Calculate y[n] = x[n]*h[n] by doing the circular convolution directly . (10 points)
4.4 Calculate y[n] of part 4.3 by multiplying the DFTs of x[n] and h[n] and performing an inverse DFT. (10 points)

5. Consider a butterworth lowpass filter whose system function is

$$H(z)=\frac{0.269Z^3+0.807Z^2+0.807Z+0.269}{Z^3-0.645Z^2+0.443Z-0.064}$$

This third-order system was designed using the bilinear transformation to meet the following specifications:

Passband frequency	0.5π rad./sec.
Stopband frequency	0.8π rad./sec.
Max. passband attenuation	1 dB
Min. stopband attenuation	20 dB

Suppose we want a highpass filter with passband cutoff frequency $\omega_p = 0.4\pi$. Use the lowpass-highpass transformation to determine the system function of this highpass filter. . (10 points)

---- End of Exam ----