Seat Number

King Mongkut's University of Technology Thonburi
Final Examination
Semester 1 – Academic Year 2014

Subject: EIE 460 Digital Signal Processing
For: Electrical Communication and Electronic Engineering, 4^{th} Yr (Inter. Program)
Exam Date: Monday, December 1, 2014 **Time:** 9.00-12.00 am.

Instructions:-

1. This exam consists of 7 problems with a total of 8 pages, including the cover.
2. This exam is opened book.
3. Answer each problem on the exam itself.
4. A calculator compiling with the university rule is allowed.
5. A dictionary is **not** allowed.
6. **Do not** bring any exam papers outside the exam room.

Remarks:-

- **Raise your hand when you finish the exam to ask for a permission to leave the exam room.**
- **Students who fail to follow the exam instruction might eventually result in a failure of the class or may receive the highest punishment with university rules.**

Exam No.	1	2	3	4	5	6	7	Total
Full Score	25	20	10	25	25	5	10	120
Graded Score								

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This examination is designed by
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This examination has been approved by the committees of the ENE department.

(Asst. Prof. Suwat Pattaramalai, Ph.D.)
Acting Head of Electronic and Telecommunication Engineering Department

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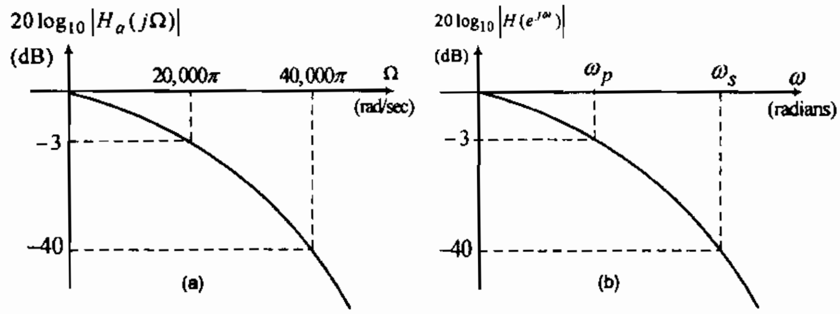
1. The frequency response of an analog filter is shown in Figure (a). The sampling rate is $F_s = 50,000$ samples/sec. Use the FIR filter design. (25 marks)



   a. Find ω_p and ω_s .
   b. Find N by using Hamming window.
   c. Find the impulse response $h[n]$.
   d. If the magnitude of the frequency response of c. obtains -3 dB at a frequency less than ω_p and -40 dB at a frequency less than ω_s, how to improve the design to satisfy the requirement as shown in Figure (b)?
   e. Find the output signal of the filter that has frequency response as shown in Figure (b) if the input signal is $x[n] = \sin(\omega_p n)$.

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2. The specification of a digital filter is as follows. (20 marks)

$$|H(e^{j\omega})| \le 0.01 \qquad |\omega| \le 0.25\pi$$

$$0.95 \le |H(e^{j\omega})| \le 1.05 \qquad 0.3\pi < |\omega| \le \pi$$

Use Kaiser window.

a. Find A_s, ω_c, N and β.

b. Use functions in Matlab to find the frequency response $H(e^{j\omega})$ where ω has 100 points between 0 to π.

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3. The difference equation between the output signal $y[n]$ and the input signal $x[n]$ is given by (10 marks)

$$y[n] = 2x[n] + 3x[n-1] - x[n-2] + x[n-3] + x[n-4] - x[n-5] + 3x[n-6] + 2x[n-7]$$

   a. Draw the filter structure in linear phase form.
   b. Find the phase response $\measuredangle H(e^{j\omega})$.

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4. Butterworth lowpass filter has the following specification: (25 marks)

$$\Omega_p = 100,\ R_p = 3 \text{ dB}, \Omega_s = 250 \text{ and } A_s = 25 \text{ dB}$$

a. Find N.
b. Find Ω_c to obtain -3 dB at $\Omega_p = 100$ rads/sec.
c. Find $H_a(s)$.
d. Explain the concept to transform $H_a(s)$ to $H(z)$ by the impulse invariant method where T_s is the sampling period.
e. Can we use the functions built in Matlab for problem d.? Give a reason.

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5. Digital lowpass filter has the following specification: (25 marks)

$$\omega_p = 0.2\pi\,,\ R_p = 1\text{ dB},\ \omega_s = 0.4\pi \text{ and } A_s = 20\text{ dB}$$

Choose Chebyshev lowpass fitler as the prototype filter and bilinear transformation method.

a. Find Ω_p, Ω_s and N.

b. Find the pole values.

c. Find $H_a(s)$.

c. Use functions in Matlab to find the frequency response $H(e^{j\omega})$ where ω has 100 points between 0 to π.

d. How do we obtain the new $H(z)$ if ω_p is changed from 0.2π to be 0.3π?

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For problem 5 continued

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6. The system function of an IIR filter is (5 marks)

$$H(z)=\frac{1-1.7321z^{-1}+z^{-2}}{1-1.3856z^{-1}+0.64z^{-2}}$$

Draw the direct form II normal.

7. Answer the following questions. (10 marks)
   a. The signal given as $x[n]=\cos(0.5\pi n)$ where $0\le n\le 63$ has the discrete Fourier Transform $|X(k)|$. What is the k value that $|X(k)|$ is maximum?
   b. The signal given as $x[n]=\cos(0.515625\pi n)$ where ที่ซึ่ง $0\le n\le 63$ has discrete Fourier Transform $|X(k)|$. Is the maximum $|X(k)|$ at the frequency of the signal $x[n]$? Give a reason.