King Mongkut's University of Technology Thonburi

Final Examination 2/2009

CPE 222 Signals and Systems	**Computer Engineering Department**
Date: March 8, 2010	**Time: 1:00 – 4:00 p.m.**

Instructions:

Violation of examination rules and regulations will not be tolerated. Serious violator could face dismissal charge.

1. **Only one calculator and one ruler with mathematical formula are allowed** in the examination room.
2. **Computers are not allowed** in the examination room.
3. **One textbook** is allowed in the examination room.
4. **Documents and notes are allowed** in the examination room.
5. **Do not take the examination sheets out** of the examination room.
6. Write your answers on the examination booklet(s).
7. This examination has **3 pages (6 problems, 100 points)**.

Part I: *(30 points)* Mathematics in Signals and Systems

1. *(10 points)* Given a system consisting of the cascade of two LTI systems as shown in Figure 1, determine the difference equation of the overall system.

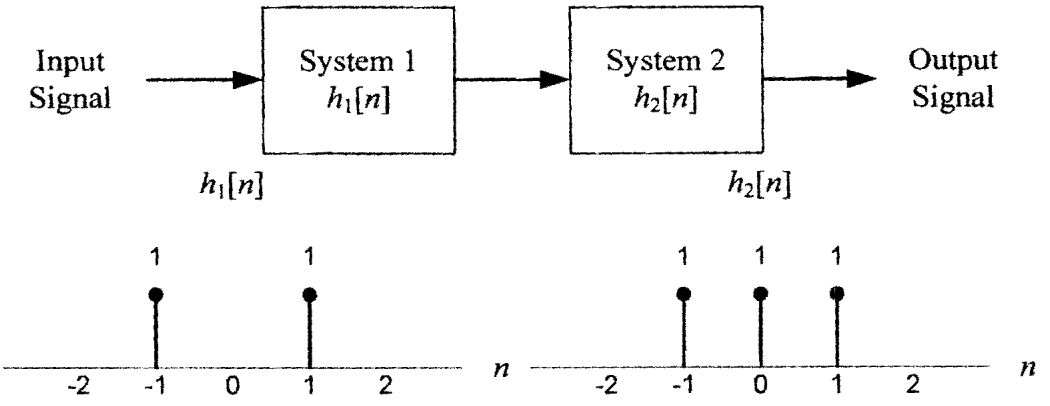

Figure 1

2. Consider a causal LTI system described by the difference equation

$$y[n]+\frac{1}{2}y[n-1]=x[n]$$

2.1. *(5 points)* Determine the frequency response $H(e^{j\omega})$ of this system.

2.2. *(5 points)* Determine the output of the system to the input with the following Fourier transform $X(e^{j\omega}) = 1 + 2e^{-j3\omega}$

3. Consider a continuous-time LTI system for which the input $x(t)$ and output $y(t)$ are related by the differential equation

$$\frac{d^2y(t)}{dt^2} - \frac{dy(t)}{dt} - 2y(t) = x(t)$$

3.1. *(3 points)* Determine the transfer function H(s) of the system.
3.2. *(3 points)* Sketch the pole-zero pattern of H(s).
3.3. *(4 points)* Determine $h(t)$. Assume that the system is stable.

Part II: *(30 points)* Understanding of Signals and Systems Concept

4. For each problem, determine whether the given statements or equations are **true** or **false**. Provide a reason to support your answer. For each problem, if you answer true/false correctly, you will gain 1 point. If you provide the right reason, you will gain 2 additional points.
4.1. *(3 points)* $h(t) = y(t)/x(t)$
4.2. *(3 points)* The continuous-time system can process the discrete-time signal.
4.3. *(3 points)* A system with an impulse response $h(t) = \delta(1-t)$ is causal.
4.4. *(3 points)* A phase response is a part of the frequency response.
4.5. *(3 points)* A causal LTI second-order system with the differential equation $\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 4y(t) = x(t)$ is underdamped.
4.6. *(3 points)* The signal $x(t) = \cos(20\pi t)\times\cos(100\pi t)$ has to be sampled at the sampling rate at least 60Hz..
4.7. *(3 points)* If the sampling frequency is less than Nyquist rate, the output of the sampling process will contain a lot of noises.
4.8. *(3 points)* The response of the system will oscillate if there are poles on the right hand side of s-plane.
4.9. *(3 points)* The system H(s) = s/(s+2) is a lowpass filter.
4.10. *(3 points)* In root locus, pole moves because the input changes its value.

Part III: *(40 points)* Problem Solving

5. *(20 points)* Electroencephalography or EEG is the recording of electrical activity produced by the firing of neurons within the brain. Activities in the different frequency band of EEG signal indicate different human actions, as described in the following table.

Type	Frequency (Hz)	Action
Delta	0 – 4 Hz	Dreaming
Theta	4 – 7 Hz	Drowsiness
Alpha	8 – 12 Hz	Relaxing
Beta	12 – 30 Hz	Working

Design a system to detect the action from the EEG signal.

6. *(20 points)* A floppy disk drive is a position control system in which a read/write head is positioned over a magnetic disk. The system responds to a command from a computer to position itself at a particular track on the disk. A block diagram are shown in Figure 2. It is important that the read/write head move without oscillation, otherwise it might damage the disk. Find the range of K to ensure that no oscillation will occur.

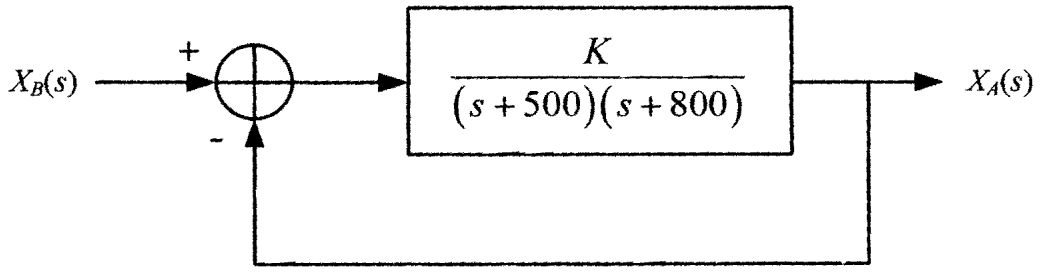

Figure 2

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