King Mongkut's University of Technology Thonburi
Final Exam of 2nd Semester, Academic Year 2007

COURSE CPE 222 Signals and Systems
Tuesday, March 4, 2008

Computer Engineering Department
01.00-04.00 p.m.

Instructions

1. Calculator and Ruler with mathematical formula are allowed in the examination room.
2. Books, documents, and notes are not allowed in the examination room.
3. Do not take the examination sheets out of the examination room.
4. This examination has 4 pages (5 problems, 100 marks).

Students will be punished if they violate any examination rules. The highest punishment is dismissal.

This examination is designed by

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Tel. 0-2470-9083

King Mongkut's University of Technology Thonburi

Final Examination 2/2007

CPE 222 Signals and Systems | **Computer Engineering Department**
Date: March 4, 2008 | **Time: 1:00 – 4:00 p.m.**

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4. This examination has **3 pages (5 problems, 100 marks)**.

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1. a) The response of an LTI c-t system when the input $x(t) = A\cos(\Omega_0 t + \theta)$ is applied to the system for $t > 0$ with zero initial condition is $y(t) = 6\cos(t + \pi/4)$. If the system function of this system is: *(10 marks)*

$$H(s) = \frac{s+2}{(s+1)^2+4}$$

Determine the value of the amplitude **A**, the angular frequency $\mathbf{\Omega_0}$ and the phase $\boldsymbol{\theta}$ of the input x(t).

b) Determine the system function, its ROC and the location of all poles and zeros of this following system: *(10 marks)*

$$h[n] = (0.5)^n\{u[n] - u[n-10]\}$$

2. Consider an LTI c-t system with the frequency response:

$$H(j\Omega) = \frac{4+j\Omega}{6+5j\Omega-\Omega^2}.$$

Determine:

a) Is this system is casual and stable? *(2 marks)*
b) The difference equation describes this system. *(2 marks)*
c) The impulse response of this system. *(4 marks)*
d) The response of this system to the input:
$$x(t) = e^{-4t}u(t) - te^{-4t}u(t).$$ *(7 marks)*

3. Given an LTI d-t system with the frequency response defined as:

$$H(e^{j\omega}) = (1 + 4\cos\omega + 2\cos 2\omega)\,(2\cos\omega)e^{-j\omega}.$$

Determine:

a) The magnitude and the phase response of this system. *(2 marks)*
b) h[4] of the impulse response. *(6 marks)*
c) The system function of this system. *(2 marks)*
d) Is this system causal and stable? Give the reason. *(4 marks)*
e) What is the response of this system to the input x[n] = u[n]? *(6 marks)*

4. a) Suppose the following information is given about the LTI system:

   i) When the input $x(t) = e^{-\alpha t}u(t)$, the response is $y(t) = (e^{-t} - e^{-\beta t})u(t)$.

   ii) When the input $x(t) = e^{t}$, the response is $y(t) = \frac{2}{3}e^{t}$.

   iii) $\int_{-\infty}^{\infty} x(t)dt = \frac{3}{2}$

   Determine the values of α and β. Dose the frequency response exist? Give the reason. *(10 marks)*

   b) Fig. 1 shows the response y[n] to the input x[n] applied to an LTI d-t system. Determine (i) the magnitude and phase response of this system; (ii) the response to the input $x[n] = \cos(\pi n/2) + \cos(\pi n/4)$. *(10 marks)*

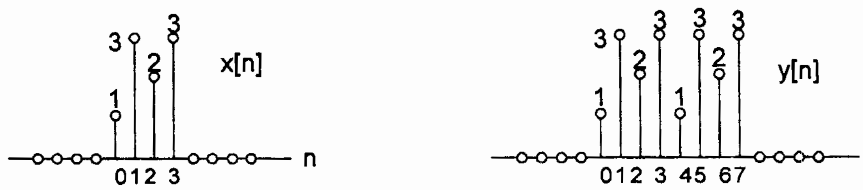

Figure 1. The input x[n] and its response y[n] of Problem 4b.

5. **Explain briefly with rational reasons supporting your answers** why you **agree** or **disagree** with these following statements.

   a) A periodic signal has a discrete line spectrum containing any frequencies. *(2 marks)*

   b) Every system that has the system function will have the frequency response. *(2 marks)*

   c) If the overall cascade of two systems is causal, each individual system must be causal. *(2 marks)*

   d) A d-t system with rational system function having only two **zeros** at **z = 0** and **z = 2** and **poles** at **z = 1** and **z = – 2** with no poles at infinity can be causal or stable but cannot be both causal and stable. *(2 marks)*

   e) The spectrum of impulse response indicates that how any LTI system reacts to sinusoidal signals of different frequencies, therefore; we will know how such system reacts to all other signals because all other signals are made up of nothing but sinusoidal oscillations. *(2 marks)*

   f) For the rational system function, if the number of zeros is greater than the number of poles, the system will be non-causal system. *(2 marks)*

   g) If any LTI system has **zero at z = 1**, such system will block **the D.C.** signals. *(2 marks)*

   h) Consider system function H(s) and a **real** impulse response h(t) of a **stable** and **causal** LTI system. H(s) has one of its poles at s = **-1+j**, one of its zeros at s = **3+j** and exactly **two zeros at infinity**. From the given information we can conclude that:

      i) H(s) has at least two more unknown finite poles. *(2marks)*

      ii) All poles of H(s) must lie in the left half of plane and the ROC must include the $j\Omega$–axis. *(2 marks)*

      iii) The ROC for H(s) is $\sigma > -1$ *(2 marks)*

e) Consider the periodic signal **x(t) with period of 0.02 sec.** It is possible to find an LTI c-t system so that the response to this input will be **cos(50πt)**.

(5 marks)

Note:

Fourier Series:

$$x(t) = \sum_{k=-\infty}^{\infty} X[k]e^{jk\Omega_0 t} \quad \text{and} \quad X[k] = \frac{1}{T}\int_0^T x(t)e^{-jk\Omega_0 t}dt$$

Discrete-Time Fourier Series:

$$x[n] = \sum_{k=0}^{N-1} X[k]e^{jk\omega_0 n} \quad \text{and} \quad X[k] = \frac{1}{N}\sum_{n=0}^{N-1} x[n]e^{-jk\omega_0 n}$$

Fourier Transform:

$$X(j\omega) = \int_{-\infty}^{\infty} x(t)e^{-j\omega t}dt \quad \text{and} \quad x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(j\omega)e^{j\omega t}d\omega$$

Discrete-Time Fourier Transform:

$$X(e^{j\omega}) = \sum_{-\infty}^{\infty} x[n]e^{-j\omega n} \quad \text{and} \quad x[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} X(e^{j\omega})e^{j\omega n}d\omega$$

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