King Mongkut's University of Technology Thonburi

Final Examination 1/2014

CPE 214 Signals and Systems	**Computer Engineering Department**
Date: December 2, 2014	**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. **Books, documents, and notes are not allowed** in the examination room.
3. Carefully read the explanation in each problem and then answer each question.
4. **Do not take the examination sheets out** of the examination room.
5. Write your answers on the examination booklet(s).
6. This examination has **4 pages (8 problems, 100 points).**

1. The following statements are true or false. Give the rational reason to support your answer. (the score depends on your explanation). *(20 points)*
   a. T/F : A system will be a causal system, if its impulse response is a right sided signal.

   b. T/F : Frequency in an image is a level of intensity. Therefore, low frequency component is a part of an image that has low intensity or darker shade.
   c. T/F : A d-c system having only poles at the unit circle (no zero) can be a causal and stable system.
   d. T/F : The DC voltage is not a signal because its value is constant all the time.
   e. T/F : A system having different equation: y[n-2]=x[n-2]+0.5x[n-1]+x[n] is a causal system.
   f. T/F : The system that performs image blurring is a low pass filter whereas edge detection is a high pass filter.
   g. T/F : Frequency of a constant is equal to zero.
   h. T/F : The system will be stable if its frequency response is exist.
   i. T/F : For any system, we can find the output of the system by convoluting the input with system's impulse response.
   j. T/F : Time invariance system is a system that its impulse response is not a function of time.

2. An LTI system has an impulse response $h(t) = \delta(t) + \delta(t+1) + \delta(t+2) + \delta(t+3)$ *(17 points)*

   a. Determine the frequency response of this system. *(5 points)*

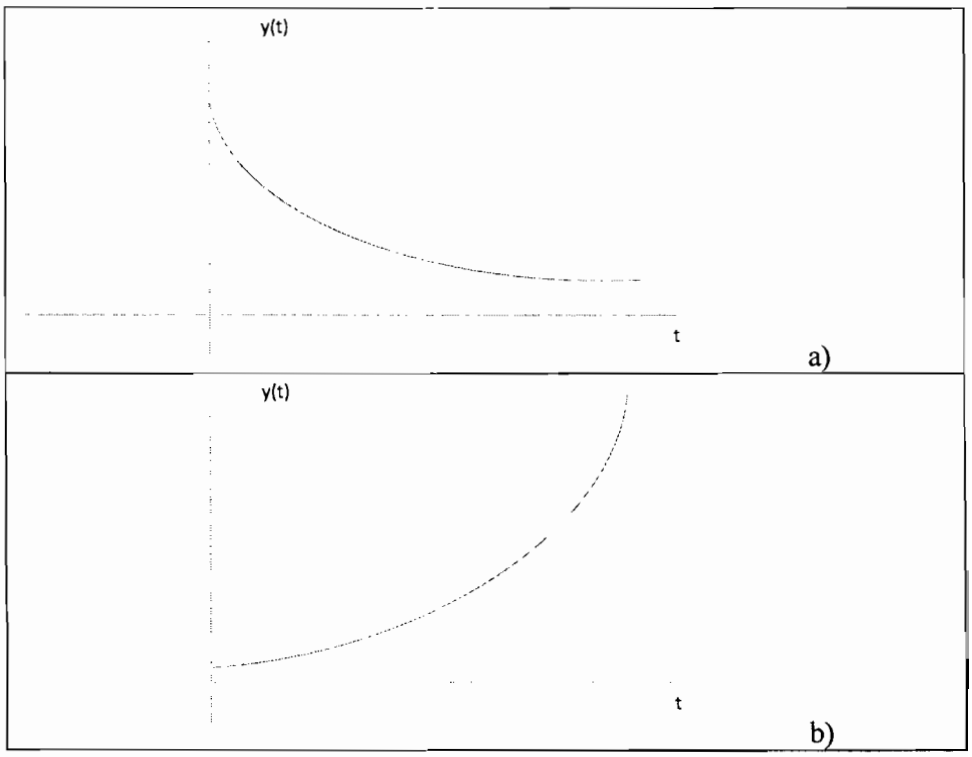
   b. Determine the response of this system to the input $x(t) = 2\cos\left(\frac{\pi}{4}t + \frac{\pi}{2}\right) + \cos\left(\pi t + \frac{\pi}{4}\right)$. *(6 points)*

   c. Determine the system function of this system. *(2 points)*

   d. Plot pole(s) and zero(s) of the system function. *(2 points)*

   e. Is this system is causal? *(2 points)*

3. A causal system have a system function $H(s) = \frac{1}{(s^2-2s-3)}$. If we apply input x(t)=u(t) to this system, without any calculation, which figure (a or b) is close to the output signal? Give the rational reason to support your answer. *(5 points)*



4. A causal LTI system has a system function $H(z) = \frac{5z+2}{z^2+3z+2}$. *(10 points)*
   a. Is this system stable? *(2 points)*
   b. Determine the impulse response of this system. *(4 points)*
   c. Determine the response of this system to the input $x[n] = (2)^n$ *(4 points)*

5. A step response of an LTI causal system is $\delta[n] + \delta[n-2]$. *(8 points)*
   a. Determine the impulse response of this system. *(4 points)*
   b. What is the different equation of this system? *(2 points)*
   c. Determine the system function of this system. *(2 points)*

6. The information of one system are given below: *(15 points)*
   i. The system is a discrete time system. The impulse response of this system is real.
   ii. The system function is rational and has exactly two zeroes and two poles.
   iii. The distances of two zeroes from the origin are 1.
   iv. This system blocks input signal having frequency $\omega = \frac{\pi}{2}$
   v. Two poles locate at the origin.
   vi. The response of this system to the input $x[n] = (-1)^n$ is 4.

   a. Determine the system function. *(10 points)*

   b. Determine the frequency response, magnitude response, and phase response of this system. *(5 points)*

7. A system S1 has system function $H_1(z) = z^2$ *(15 points)*
   a. Is this system a causal system *(2 points)*
   b. System S1 is serially connected with system S2 having $H_2(z) = \frac{1}{z^2-\frac{3}{2}z+\frac{1}{2}}$. What is the overall system function? *(2 points)*
   c. Plot pole(s) and zero(s) of the overall system function. *(2 points)*
   d. Determine the impulse response of the overall system (assume that the system is causal). *(5 points)*
   e. Find the output of the overall system function when input $x[n] = e^{j\pi n}$ *(4 points)*

8. Given $H(s) = \frac{1}{s^2+s-2}$. Determine $h[n]$ when *(10 points)*
   a. $h(t)$ is absolutely summable. *(5 points)*

   b. the system is a causal system. *(5 points)*

Note:

Fourier Transform:

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

Discrete-Time Fourier Transform:

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

Laplace Transform:

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

z – Transform:

$$X(z) = \sum_{-\infty}^{\infty} x[n]z^{-n} \qquad \text{and} \qquad x[n] = \frac{1}{2\pi j}\oint X[z]z^{n-1}dz$$

Summation Formulas

$$\sum_{k=0}^{n} a^k = \frac{1-a^{n+1}}{1-a} \quad a \neq 1 \qquad \sum_{k=0}^{n} ka^k = \frac{a[1-(n+1)a^n + na^{n+1}]}{(1-a)^2}$$

$$\sum_{k=0}^{\infty} ka^k = \frac{a}{(1-a)^2} \quad |a|<1 \qquad \sum_{k=0}^{\infty} a^k = \frac{1}{1-a} \quad |a|<1$$

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