King Mongkut's University of Technology Thonburi

Midterm Examination 1/2014

CPE 214 Signals and Systems **Computer Engineering Department**

Date: September 26, 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 is 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 **3 pages (7 problems, 60 points)**.

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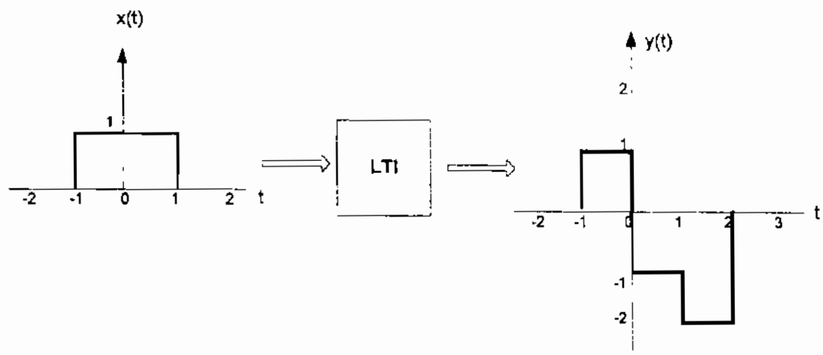
1. Determine the fundamental frequency ω_0 and the Fourier series coefficients a_k of the following signals. ***(7 points)***
   a) $x(t) = 2 + \cos\left(\frac{2\pi}{3}t\right) + 4\sin(\frac{5\pi}{3}t)$ *(2 points)*
   b) $x[n] = (-1)^n$ *(3 points)*
   c) $x[n] = 1 + \sin(\frac{3\pi}{8}n + \frac{\pi}{4})$ *(2 points)*

2. Determine the Fourier transform, the magnitude, and phase of Fourier transform of the following signals ***(6 points)***
   a) $x(t) = \delta(t+1) + \delta(t-1)$ *(3 points)*
   b) $x(t) = e^{-2(t+1)}u(t-1)$ *(3 points)*

3. Consider a causal LTI system with frequency response
   $H(jw) = \frac{1}{j\omega+3}$
   For a particular input x(t) this system is observed to produce the output
   $$y(t) = e^{-3t}u(t) - e^{-4t}u(t)$$
   Determine: ***(7 points)***
   a) Magnitude and phase of frequency response. *(2 points)*
   b) The input x(t). *(3 points)*
   c) Impulse response of this system. *(2 points)*

4. Consider an LTI system that is characterized by the difference equation $y[n] - 0.5y[n-1] = x[n]$
Determine: ***(8 points)***
a) Frequency response of this system *(2 points)*
b) Impulse response of this system. Is this system a causal system? *(3 points)*
c) The response of this system to the input $x_1[n] = \delta[n-1] + \delta[n+2]$ *(3 points)*

5. Given input-output pair of an LTI system as following:



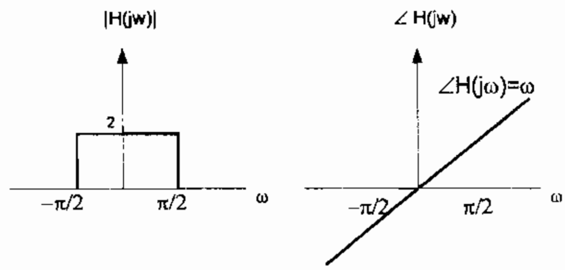
Determine: ***(9 points)***
a) The impulse response (h(t)) of this system. *(5 points)*
b) The response of this system when the input is $x_1(t) = u(t)$ *(2 points)*
c) The magnitude and phase of Frequency response of this system. *(2 points)*

6. The frequency response of an LTI system is ***(8 points)***

$$H(e^{j\omega}) = \frac{-12 + 5e^{-j\omega}}{12 - 7e^{-j\omega} + e^{-j2\omega}}$$

a) Determine the difference equation of this system. *(3 points)*
b) Determine the response of this system to the input $x[n] = (\frac{1}{2})^n u[n]$ *(4 points)*
c) Is this system a causal system? *(1 point)*

7. Magnitude and phase of frequency response for an LTI system is shown in the figure below. Determine the output of the system when input is ***(15 points)***
   a) $x1(t) = e^{j\frac{\pi t}{4}}$ *(7 points)*
   b) $x2(t) = \cos\left(\frac{3\pi}{2}t\right) + \cos(\frac{\pi}{2}t)$ *(8 points)*



Note:

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:

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

Laplace Transform:

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

z – Transform:

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

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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