King Mongkut's University of Technology Thonburi

Midterm Examination 1/2011

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

Date: July 25, 2011 | **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).**

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1. a). Determine the complex frequency components of these following signals:
   i. $x_1(t) = e^{2t}\,u(-t) + e^{3t}u(-t)$ *(3 points)*
   ii. $x_2[n] = (1/3)^n\,u[-n-1]$ *(3 points)*

   b). Determine the spectrum of these following signals:
   i. $x_3[n] = (0.25)^{n+2}\,u[n-2]$ *(3 points)*
   ii. $x_4(t) = \sin(2\pi t)\,e^{-t}\,u(t)$ *(3 points)*

   c). Determine the magnitude and phase spectrum of this following signal:

$$x_5[n] = \begin{cases} 1 & n=-4,-2,2 \\ -1 & n=4 \\ 0 & \text{Otherwise} \end{cases}$$ *(3 points)*

2. Determine the Fourier Transform Representation of the following signals
   a) $x(t)=\sin(5t+1.5\pi)\delta(t)$ *(2 points)*

   b) $x(t)$ as depicted in Figure 1. *(3 points)*

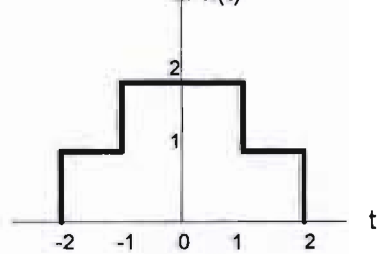


Figure 1.

c) *(5 points)*

$$x(t) = \begin{cases} 0 & ,|t|>1 \\ \frac{1}{2}(t+1) & ,-1 \le |t| \le 1 \end{cases}$$

3. Determine the time domain signals of these following frequency domain components:

   a) $X(z) = 4 + 3(z^2 + z^{-2})$ $\quad 0 < |z| < \infty$ *(2 points)*

   b) $X(j\omega) = 2\pi\delta(\omega) + \pi\delta(\omega - 4\pi) + \pi\delta(\omega + 4\pi)$ *(3 points)*

   c) $X(j\omega) = \dfrac{1}{(a+j\omega)^2} e^{j2\omega}$ *(3 points)*

   d) $X(s) = \dfrac{s+2}{s^2 + 7s + 12}$ $\quad -4 < R\{s\} < -3$ *(3 points)*

   e) $X(e^{j\omega}) = \dfrac{1}{1 - \frac{1}{3} e^{-j10\omega}}$ *(4 points)*

4. Consider an LTI system with the spectrum of h[n], which is,

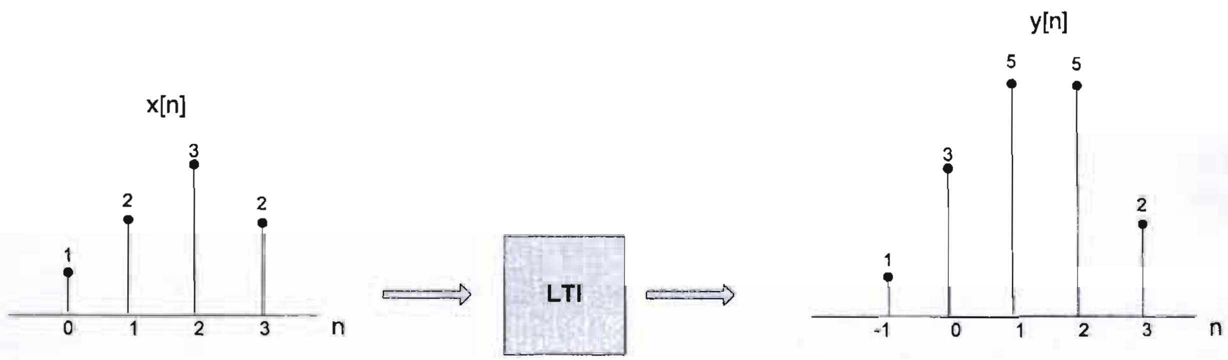
$$H(e^{j\omega}) = \frac{1-a^2}{(1-ae^{-j\omega})(1-ae^{j\omega})} \qquad |a| < 1. \text{ Determine:}$$

   a) The impulse response of this system. *(8 points)*

   b) Evaluate this following quantity: $\dfrac{1}{2\pi}\displaystyle\int_{-\pi}^{\pi} H(e^{j\omega})\cos(\omega)d\omega$. *(7 points)*

5. Given $X(e^{j\omega}) = \dfrac{1}{1-ae^{-j\omega}}$ with $-1 < a < 0$. Determine: (a) the real part, (b) the imaginary part, (c) the magnitude, and (d) the phase of $X(e^{j\omega})$. *(10 points)*

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



a) Determine the impulse response (h[n]) of this system. *(3 points)*

b) Determine the response of this system when the input is $x_1[n] = \delta[n+2] + 2\delta[n+1] - \delta[n] + 2\delta[n-1] - \delta[n-2]$ *(4 points)*

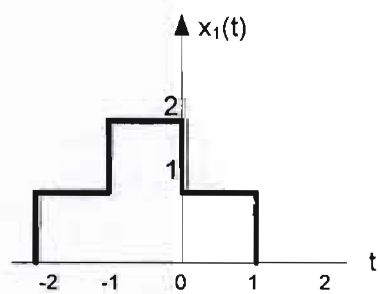
c) Determine the spectrum of the impulse response ($H(e^{j\omega})$) calculated in a). What are magnitude and phase of $H(e^{j\omega})$.

(8 points)

7. Consider an LTI system whose response to the input signal $x(t) = u(t+1)-u(t-1)$ is

$$y(t) = \begin{cases} 5t & ,0 \le t < 2 \\ t^2 + 6 & ,2 \le t \le 4 \\ 0 & , otherwise \end{cases}$$

Determine the response of this system to the following input: *(10 points)*



8. Given an LTI system with the impulse response $h[n] = (0.25)^n u[n+8]$. The output of this system is multiplied by a unit step signal u[n]. Is the overall system will be LTI, causal, and BIBO stable? *(10 points)*

Note:

Sinc Function

$$\operatorname{sinc}(x) \equiv \begin{cases} 1 & \text{for } x = 0 \\ \dfrac{\sin x}{x} & \text{otherwise,} \end{cases}$$

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:

$$X(s) = \int_{-\pi}^{\pi} x(t)e^{-st}dt$$

z – Transform:

$$X(z) = \sum_{-\infty}^{\infty} x[n]z^{-n}$$

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