**King Mongkut's University of Technology Thonburi**

**Midterm Examination 2/2009**

**CPE 222 Signals and Systems** — **Computer Engineering Department**

**Date: December 25, 2009** — **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 **3 pages (8 problems, 100 points)**.

1. *(6 points)* Determine the magnitude and phase of these following complex numbers:

   a) $-je^{-j\pi}(1-j)^3$ *(3 points)*

   b) $(4+j3)(\cos 53° + j\sin 53°)e^{j\frac{\pi}{2}}$ *(3 points)*

2. *(6 points)* Sketch the graph of these following signals:

   a) $x(t) = \begin{cases} t+2 & -2 \le t \le 0 \\ -t+2 & 0 \le t \le 2 \\ 0, & \text{otherwise} \end{cases}$ *(3 points)*

   b) $x[n] = \sum_{k=2}^{+\infty} \delta[n-k]$ *(3 points)*

3. *(8 points)* Given a continuous-time signal x(t) defined as in Figure 1. Sketch and label carefully of the signal $w(t)$ where:

   a) $w(t) = x(-2t-2)$ *(4 points)*

   b) $w(t) = \int_{-\infty}^{+\infty} \delta(\tau-1)x(t-\tau)\,d\tau$ *(4 points)*

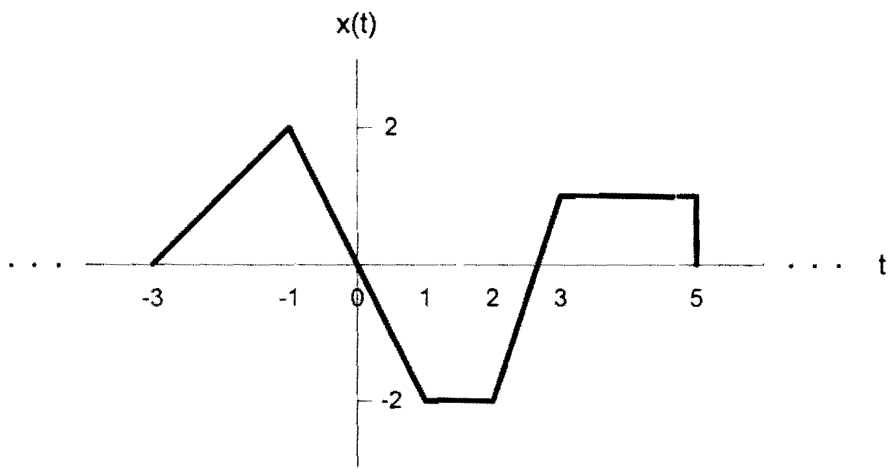


Figure 1 The given continuous-time signal $x(t)$ for problem 3.

4. *(15 points)* Given the continuous-time signals x(t) and v(t) defined as follows. Compute the convolution $x(t)*v(t)$. Explain every detail of your work.

$$x(t)=\begin{cases}-2, & -1<t<0\\ 2, & 0<t<1\\ 0, & \text{elsewhere}\end{cases} \qquad v(t)=\begin{cases}t, & 0<t<1\\ 0, & \text{elsewhere}\end{cases}$$

5. a) *(5 points)* Determine the Laplace transform of the continuous-time signal $x(t)$ defined as follows:

$$x(t)=\int_{0}^{+\infty} e^{-\tau}(t-\tau)e^{-2(t-\tau)}u(t-\tau)\,d\tau$$

b) *(5 points)* Determine the impulse response of the causal LTI system having the transfer function defined as follows:

$$H(s)=\left(e^{-5s}-e^{-3s}\right)\left(\frac{s-1}{s^2-1}\right)$$

c) *(5 points)* Determine the system function of an LTI system having these following input and output:

$$x[n]=(-1)^n 2^{-n}u[n] \quad \text{and} \quad y[n]=\frac{1}{2}(n^2+n)\left(\frac{1}{3}\right)^{n-1}u[n-1].$$

6. *(15 points)* Given an LTI system having the frequency response $H(e^{j\omega})$ defined as follows:

$$H\left(e^{j\omega}\right)=\frac{j\omega}{(j\omega+1)(j\omega+2)}$$

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

b) the time-domain response of this system to the input signal: *(10 points)*

$$x(t)=\cos 2t$$

7. *(20 points)* Given an LTI system having the characteristic described by the following equation:

$$h[n] = -\delta[n+1] + \delta[n]$$

Determine: a) the discrete-time Fourier transform of $h[n]$, $H(e^{j\omega})$. *(5 points)*

b) the time-domain response of this system to the input signal: *(15 points)*

$$x[n] = 1 + (j)^n + \sin\left(\frac{\pi}{2}n + \frac{\pi}{5}\right)$$

8. *(15 points)* Given an LTI system having the impulse response defined as:

$$h[n] = \begin{cases} (0.5)^n & 0 \le n \le 2 \\ 0 & \text{otherwise} \end{cases}.$$

Determine the input *x[n]* of this system which will excite the system to have the response:

$$y[n] = \delta[n] + \frac{3}{2}\delta[n-1] + \frac{19}{4}\delta[n-2] + \frac{9}{4}\delta[n-3] + \delta[n-4].$$

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