New Mexico State University
Klipsch School of Electrical Engineering

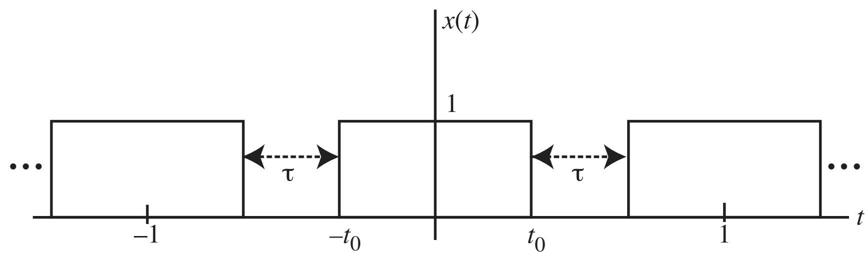
EE312 - Signals and Systems I
Spring 2010
Exam #2

Name: ____________________

Prob. 1	/ 20 points
Prob. 2	/ 20 points
Prob. 3	/ 20 points
Prob. 4	/ 20 points
Prob. 5	/ 20 points
Total	/ 100 points

Prob. 1

Consider the even, periodic signal $x(t)$ shown below where the period $T = 1$ and the time between pulses is controlled by a fixed constant, $0 < \tau < 1$.



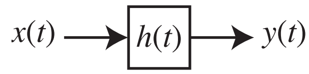
(a) Determine t_0 in terms of τ. Note that $2t_0$ is the pulse width which is needed for (b).

(b) Compute the Fourier Series (FS) coefficients, a_k for the signal $x(t)$.

Included in your solution should be the parameter τ.

Prob. 2

Consider the linear, time-invariant (LTI) system



where the impulse response is

$$h(t) = e^{-2t}u(t) \tag{2.1}$$

and the output signal is

$$y(t) = \frac{1}{2}e^{-2t}u(t) - \frac{1}{2}e^{-4t}u(t). \tag{2.2}$$

We wish to determine the input signal, $x(t)$.

(a) Determine the frequency response, $H(j\omega)$ and output spectrum, $Y(j\omega)$.

(b) Sketch the magnitude response, $|H(j\omega)|$ vs. ω for $\omega \geq 0$. Include on your sketch the values for $|H(j0)|$, $|H(j1)|$ and $|H(j\infty)|$.

Prob. 2 (cont.)

(c) Determine the input spectrum, $X(j\omega)$.

(d) Determine the input signal, $x(t)$.

Prob. 3

A causal LTI system is described by the LCCDE

$$y[n] - \frac{8}{15}y[n-1] + \frac{1}{15}y[n-2] = x[n-1] \tag{3.1}$$

with initial rest conditions, i.e. $y[-2] = y[-1] = 0$.

(a) Determine the frequency response, $H(e^{j\omega})$.

(b) Inverse transform your answer in (a) to determine the impulse response, $h[n]$.

Prob. 4

(a) Consider a continuous-time (CT) system with impulse response

$$h(t) = \frac{1}{4}e^{-4t}u(t) \tag{4.1}$$

and an input signal composed of two complex exponential signals

$$x(t) = \frac{1}{2}e^{j2t} + \frac{1}{3}e^{j3t}. \tag{4.2}$$

Use *eigenfunction* theory to determine the output signal, $y(t)$.

(b) Consider a discrete-time (DT) system described by

$$y[n] = \frac{1}{2}y[n-1] + x[n] \tag{4.3}$$

with initial rest conditions, i.e. $y[-1] = 0$ and an input signal composed of three complex exponential signals

$$x[n] = 1 + e^{j\pi n/2} + e^{j\pi n}. \tag{4.4}$$

Use *eigenfunction* theory to determine the output signal, $y[n]$.

Prob. 5

Determine the Fourier Transform (FT) $X(j\omega)$ for the given $x(t)$ or the Discrete-Time Fourier Transform (DTFT) $X(e^{j\omega})$ for the given $x[n]$.

You may use any method including basic FT/DTFT pairs and properties [p. 328 Table 4.1, p. 329 Table 4.2/p. 391 Table 5.1, p. 392 Table 5.2], direct expansion into complex exponentials, or direct calculation [p. 288 (4.9)/p. 361 (5.9)].

(a) $x(t) = 1 + 2\cos(3\pi t)$. $X(j\omega) = ?$ Sketch $|X(j\omega)|$ vs. ω, $-\infty < \omega < \infty$.

(b) $x(t) = \begin{cases} 2\cos(\pi t), & |t| \le 1 \\ 0, & |t| > 1. \end{cases}$ Sketch $x(t)$ vs. t. $X(j\omega) = ?$

Prob. 5 (cont.)

(c) $x[n] = \delta[n+1] + 2\delta[n] + \delta[n-1]$. $X(e^{j\omega}) = ?$ Sketch $|X(e^{j\omega})|$ vs. ω, $-\pi < \omega < \pi$.

(d) $x[n] = 2^n \sin(\pi n/4) u[-n]$. $X(e^{j\omega}) = ?$