EE120 Spring 97
Midterm #1
Professor Fearing

Problem #1 (20 points)

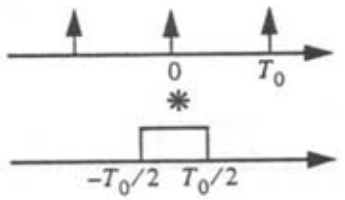
Classify the following system. In each column (except the last), write "yes", "no", or "?" (Use "?" if not decidable with given information). The input to the system is x(t) and output is y(t). Determine the impulse response of the system in the last column; if it does not exist, write "?".

Point Values:	**0.5**	**0.5**	**0.5**	**0.5**	**3**
System	**Causal**	**Linear**	**Time-invariant**	**BIBO stable**	*h(t)*
a. $y(t) = x(t) * [\delta(t) + \delta(t+2)]$					
b. $\dot{y}(t) = -5y(t) + x(t)$					
c. $y(t) = \frac{1}{5}[x(t-5)]^2 + 20[x(t+7)]^{1/2}$					
d. $y(t) = x(t) + \int_{-\infty}^{+t} x(\tau)e^{-5(t-\tau)}d\tau$					

Problem #2 (30 points)

Answer each part independently, using the sketches on the next page. The sketches on the next page can be used as either spectra or time plots. The vertical scale, horizontal scale and origin in each of the answer sketches are arbitrary, and independent.

a)



The convolution is sketch:

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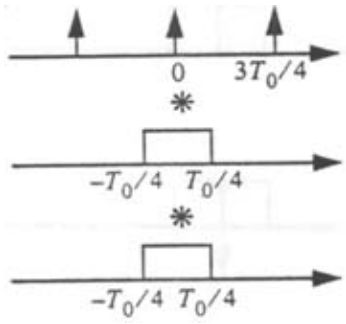
b)

The convolution is sketch:



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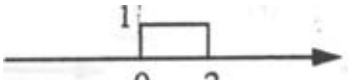
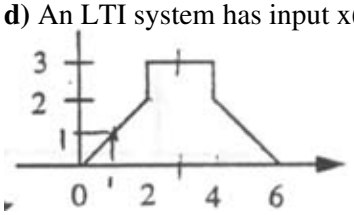
c) An LTI system has a unit step output for a unit impulse input. What is the time output of the system for a waveform (as in sketch G)?

d) An LTI system has input x(t) 

and output y(t)



The output for an impulse input is sketch:

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e)What is the Fourier Transform of $x(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT_0)$? Spectrum is sketch:

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f)y(t) = sin(pi * t) * sin(2 * pi * t). y(t) is sketch:

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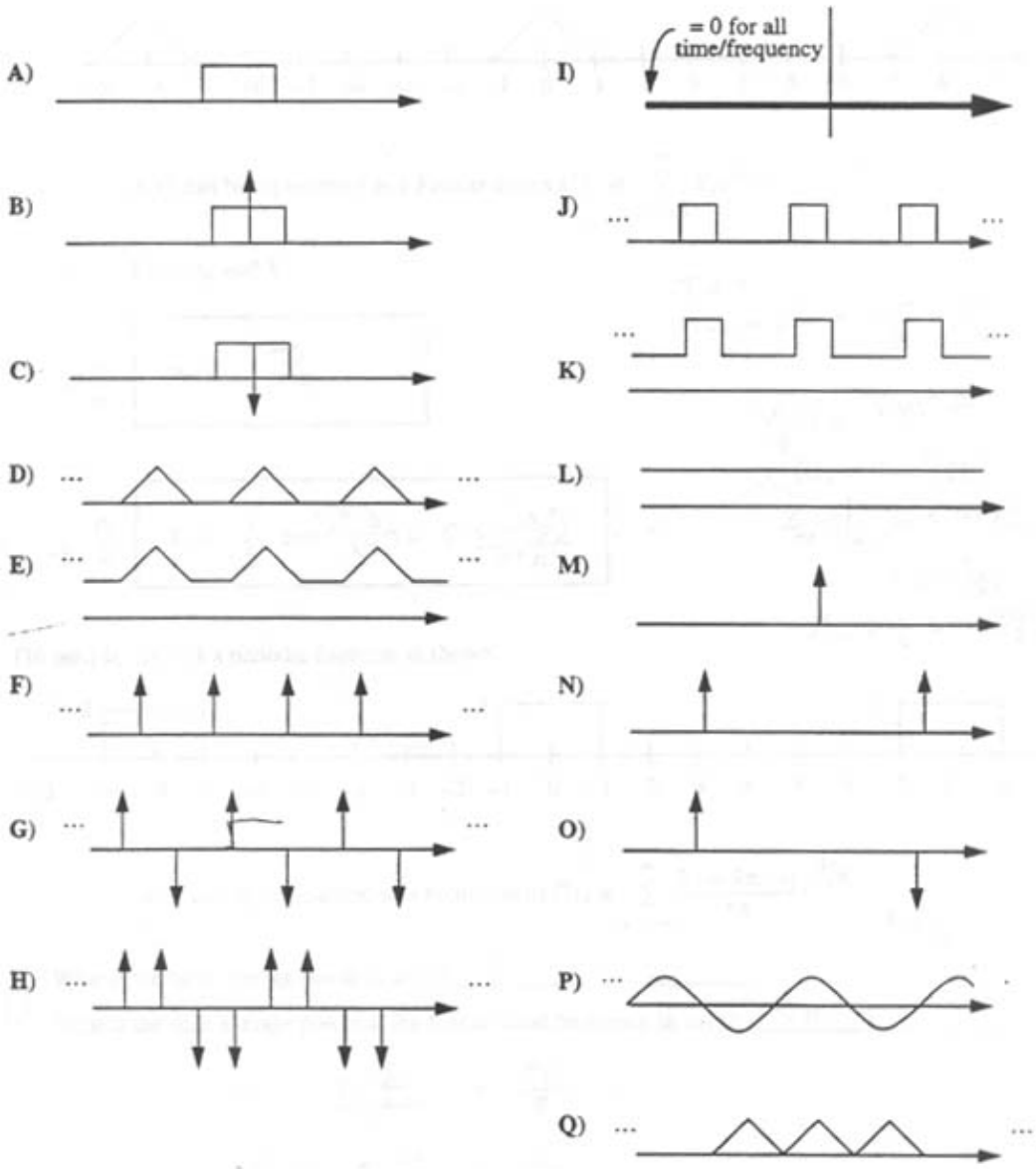
g) Bonus (5 pts.): What is the spectrum of $\sum_{n=-\infty}^{\infty} \frac{\sin\pi(t-n)}{\pi(t-n)}$? Spectrum is sketch:

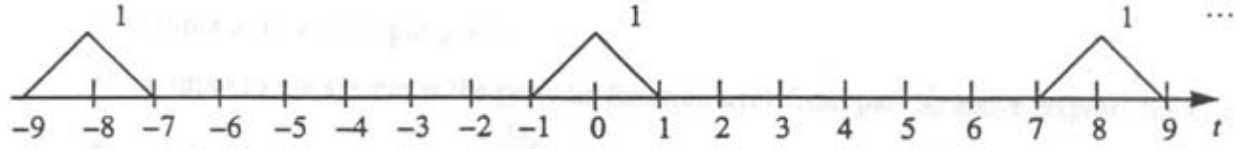
Sketches to be used as answers for Problem 2

The sketches on this page can be used as either spectra or time plots.
The vertical scale, horizontal scale, and origin in each of the answer sketches are arbitrary, and should be considered independent.
(D-K are periodic. P is periodic.)



Problem #3 (35 points) Fourier Series

[10 pts.] a) x(t) is a periodic function as shown:



$$x(t) = \sum_{k=-\infty}^{\infty} X_k e^{jk\omega_0 t}.$$

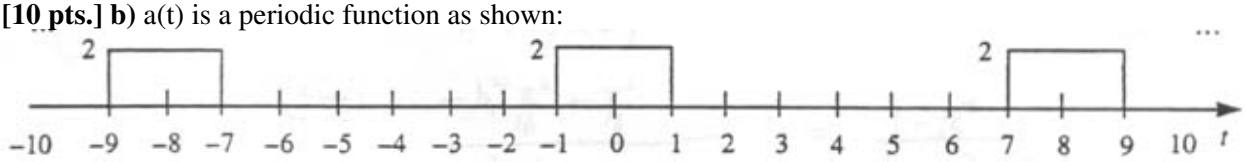
x(t) can be represented as a Fourier Series

Find w_o and X_k.

w_o =

X_k =

[10 pts.] b) a(t) is a periodic function as shown:



a(t) can be represented as a Fourier Series $x(t) = \sum_{k=-\infty}^{\infty} \frac{2\sin(k\pi/4)}{k\pi} e^{j\frac{k\pi}{4}t}$.

What is the time average power in a(t)?

What is the time average power at the fundamental frequency in a(t)?

[15 pts.] c) Consider a system whose behavior is specified by the differential equation

$$\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} + y(t) = \frac{d^2x(t)}{dt^2} + \frac{\pi^2}{16}x(t)$$

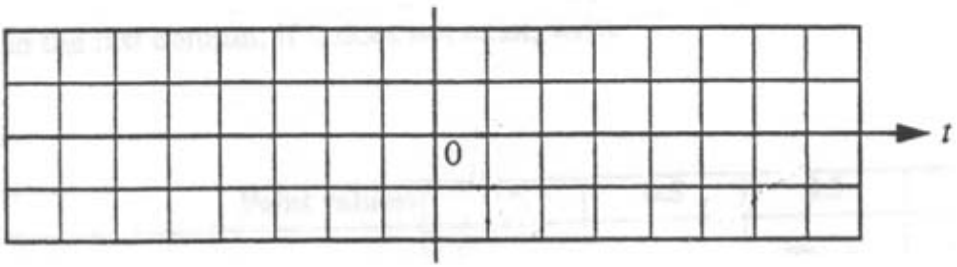
with input x(t) and output y(t).

If the input to the system is the periodic function a(t) from part 3b above, express the output as a Fourier Series $b(t) = \sum_{k=-\infty}^{\infty} b_k e^{j\frac{k\pi}{4}t}$. Find b_k

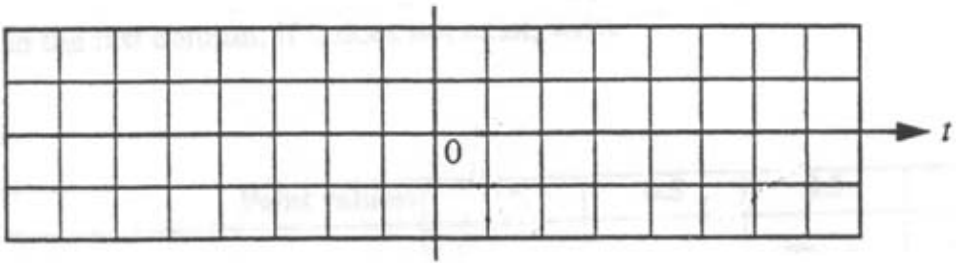
Bonus (2 pts.) (only applicable if you got b_k right): What is the time average power at the fundamental frequency in b(t)?

Problem #4 (15 points)

a) Sketch $\delta(t-1/2)\cos 2\pi t$, labelling important amplitudes and times.

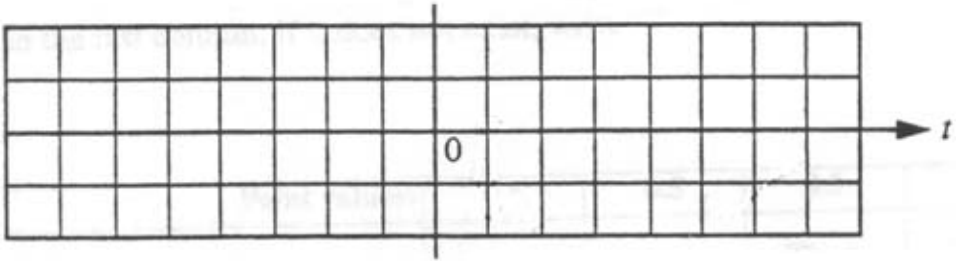


b) Sketch $\delta(t-1/2) * \cos 2\pi t$, labelling important amplitudes and times.



c) Evaluate $\int_{-\infty}^{\infty} \delta(\tau-1/2)\cos 2\pi\tau d\tau =$

d) Sketch the Fourier Transform of $\Pi(t) * \Sigma\delta(t-2n)$, labelling important amplitudes and frequencies.



e) Sketch the Fourier Transform of $\Pi(t) * \Sigma\delta(t-n)$, labelling important amplitudes and frequences.