University of California
College of Engineering
Department of Electrical Engineering
and Computer Science

Professor Wong   Spring 1994
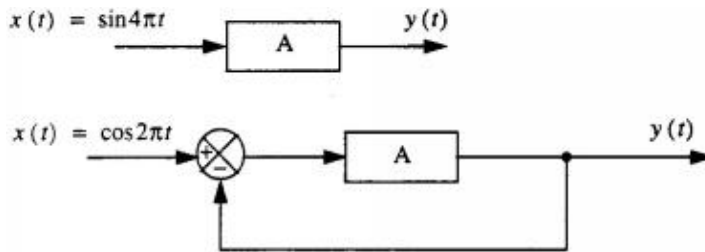
EECS 121 -- MIDTERM 1
(Closed book and notes)

1. Consider a linear and time-invariant system (denoted by *A*) for which an input $x(t) = \cos 2(\pi)ft$ produces an output

$y(t) = 1 / (1 + (2(\pi)f)^2) * (\cos 2(\pi)ft + (2(\pi)f)\sin 2(\pi)ft)$

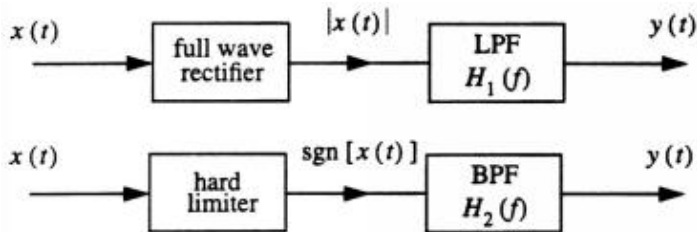Find the output $y(t)$ in each of the following situations.

2. Consider a narrowband signal

$x(t) = A(t) \cos (200(\pi)t + (theta)(t))$

where $A(t) = ((\sin(\pi)t / ((\pi)t))^2$ and $(theta)(t) = 2(\pi)\sin 2(\pi)t$.

Find the output $y(t)$ of each of the following systems where $x(t)$ is the input:

The filter transfer functions are given by

$H_1(f) = 1$, $|f| <= 1$; $= 0$ otherwise $H_2(f) = 1$, if $|f - 100| <= 1$ or $|f + 100| <= 1$; $= 0$ otherwise

3. Let *X* be a random variable with a probabilty density function given by
$PX = 1/2$ $|x| <= 1$; $= 0$ $|x| > 1$

a. Find $E|X|$
b. Let Y be another random variable whose conditional density given *X* is

$p(y|x) = 1 / \text{root}(2(\text{pi})) * e^{\wedge}(-1/2 * (y - x)^{\wedge}2)$

Find *EXY*.

4. For each of the following functions $R(t, s)$, determine whether it can be an autocorrelation function. Explain.

a. $R(t, s) = e^{\wedge}(-|t - s|) * \cos 20(\text{pi})(t - s)$
b. $R(t, s) = \cos^{\wedge}2(t + s)$
c. $R(t, s) = 1 - t - s + ts, 0 <= s, t <= 1$

5. Let X_t have a power spectral density function

$P_X(f) = 1 , |f| <= 1 ; = 0$ otherwise

a. Find the autocorrelation function $R_x(\text{tau})$.
b. Let X_t be the input and Y_t the output to a linear and time invariant system with transfer function

$H(f) = e^{\wedge}(-|f|) ,$ -infinity $< f <$ infinity

Find the average power of the output $E|Y_t|^{\wedge}2$.