

6.003: Signals and Systems—Fall 2003

PROBLEM SET 4

Issued: September 25, 2003

Due: October 3, 2003

REMINDER: Computer Lab #1 is due on October 8.

REMINDER: Quiz 1 will be held from 7:30 - 9:30 p.m. Tuesday, October 14 in Walker Memorial. The quiz will cover material in Chapters 1 -3 of O & W, Lectures and Recitations through September 26, Problem Sets # 1-3, and that part of Problem Set #4 involving problems from Chapter 3.

Reading Assignments:

Lectures #7-8 & PS#4: Chapter 3 of O&W

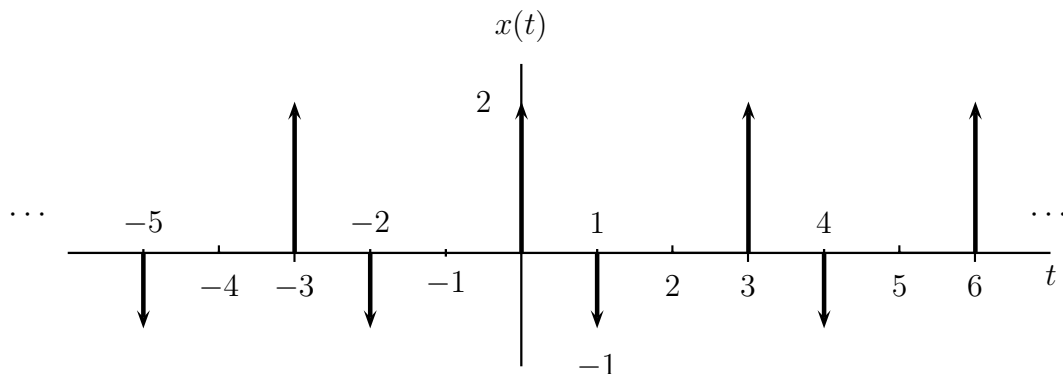
Lectures #9-11 & PS#5: Chapters 4&5 of O&W, plus begin Chapter 6 (through Section 6.2)

Exercise for home study (not to be turned in, although we will provide solutions):

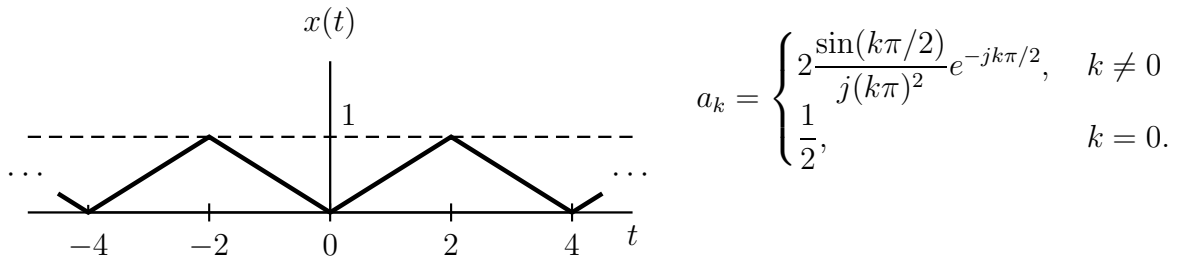
(E1) O&W 3.63

Problems to be turned in:

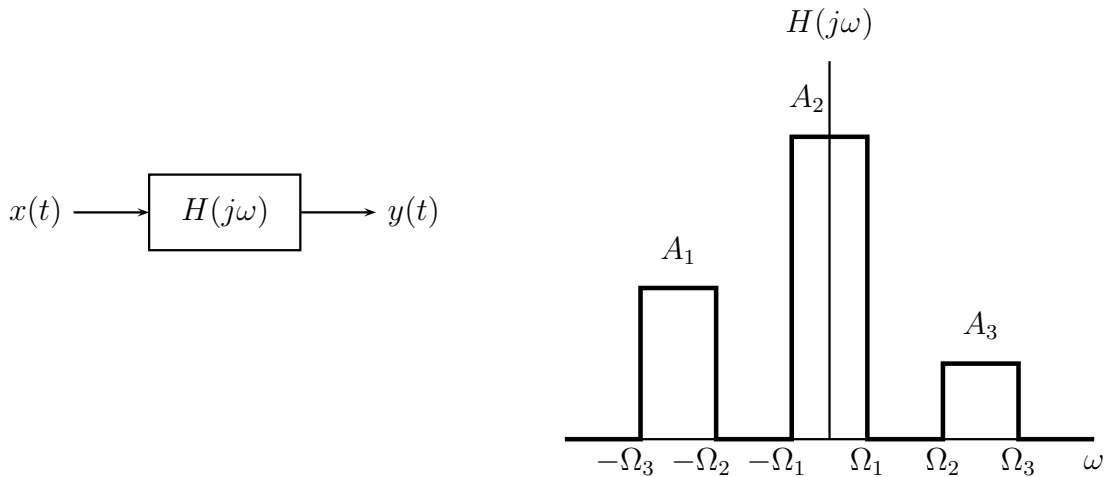
Problem 1 Consider the LTI system with impulse response given in O&W 3.34. Find the Fourier series representation of the output $y(t)$ for the following input.



Problem 2 The periodic triangular wave shown below has Fourier series coefficients a_k .



Consider the LTI system with frequency response $H(j\omega)$ depicted below:



Determine values of A_1 , A_2 , A_3 , Ω_1 , Ω_2 , and Ω_3 of the LTI filter $H(j\omega)$ such that

$$y(t) = 1 - \cos\left(\frac{3\pi}{2}t\right).$$

Problem 3 Consider a causal discrete-time LTI system whose input $x[n]$ and output $y[n]$ are related by the following difference equation:

$$y[n] - \frac{1}{4}y[n-1] = x[n] + 2x[n-4]$$

Find the Fourier series representation of the output $y[n]$ when the input is

$$x[n] = 2 + \sin(\pi n/4) - 2 \cos(\pi n/2).$$

Problem 4 Specify the frequency response of a discrete-time LTI system so that if the input is

$$x[n] = 2 + \cos(\pi n) - \sin(\pi n/2) + 2 \cos(\pi n/4 + \pi/4)$$

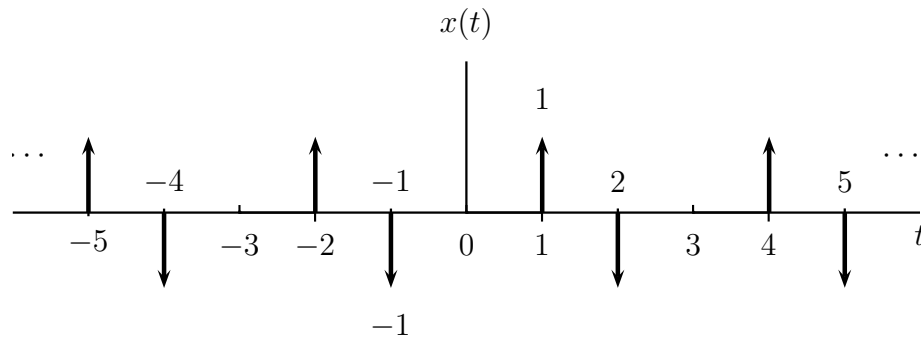
then the output is

$$y[n] = 4 - 2 \sin(\pi n) + 2 \cos(\pi n/4).$$

Problem 5 Compute the Fourier transform of each of the following signals:

(a) $x(t) = e^{-|t|} \cos 2t$

(b) The signal $x(t)$ depicted below:

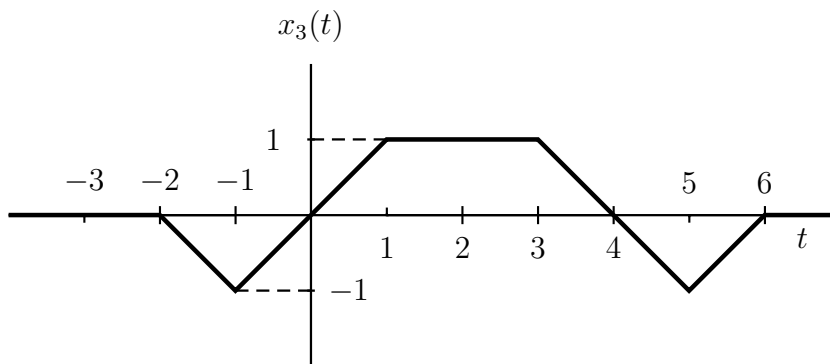
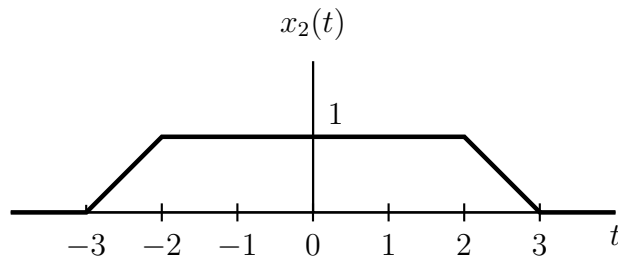
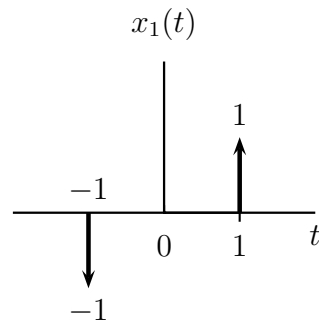


Problem 6 Determine the continuous-time signal corresponding to each of the following transforms:

(a) $X(j\omega) = j [\delta(\omega + 1) - \delta(\omega - 1)] - 3 [\delta(\omega - \pi) + \delta(\omega + \pi)]$

(b) $X(j\omega) = 2 \sin(2\omega - \pi/2)$

Problem 7 Answer the questions asked in O&W 4.24 (a) for each of the following signals:



Problem 8 O&W 4.25. Do parts (b) - (f) plus the following new part (a)

(a) $X(j\omega)$ can be written as $A(j\omega)e^{j\theta(j\omega)}$ where $A(j\omega)$ and $\theta(j\omega)$ are real. Find $\theta(j\omega)$.

Reminder: The first 20 problems in each chapter of O&W have answers included at the end of the text. Consider using these for additional practice, either now or as you study for tests.