UNIVERSITY OF TORONTO
FACULTY OF APPLIED SCIENCE AND ENGINEERING
DIVISION OF ENGINEERING SCIENCE

ECE355H1 F - Signal Analysis and Communication

Problem Set 1
Fall 2023

Submit by: **September 22, 2023**

Problem 1

(Problem 1.4 (a, b, e) - Textbook)

Let $x[n]$ be a signal with $x[n] = 0$ for $n < -2$ and $n > 4$. For each signal given below, determine the values of n for which it is guaranteed to be zero.

a) $x[n-3]$

b) $x[n+4]$

c) $x[-n-2]$

Problem 2

(Problem 1.9 - Textbook)

Determine whether or not each of the following signals is periodic. If a signal is periodic, specify its fundamental period.

a) $x_1(t) = je^{j10t}$

b) $x_2(t) = e^{(-1+j)t}$

c) $x_3[n] = e^{j7\pi n}$

d) $x_4[n] = 3e^{j3\pi(n+1/2)/5}$

e) $x_5[n] = 3e^{j3/5(n+1/2)}$

Problem 3

(Problem 1.13 - Textbook)

Consider the continuous-time signal

$$x(t) = \delta(t+2) - \delta(t-2)$$

Calculate the value of E_∞ for the signal

$$y(t) = \int_{-\infty}^{t} x(\tau)\, d\tau.$$

Problem 4

(Problem 1.14 - Textbook)

Consider a periodic signal

$$x(t) = \begin{cases} 1, & 0 \leq t \leq 1 \\ -2, & 1 < t < 2 \end{cases}$$

with period $T = 2$. The derivative of this signal is related to the "impulse train"

$$g(t) = \sum_{k=-\infty}^{\infty} \delta(t - 2k)$$

with period $T = 2$. It can be shown that

$$\frac{dx(t)}{dt} = A_1 g(t - t_1) + A_2 g(t - t_2).$$

Determine the values of A_1, t_1, A_2, and t_2.

Problem 5

(Problem 1.21 (c, f) - Textbook)

A continuous-time signal x(t) is shown in Figure 1. Sketch and label carefully each of the following signals:

a) $x(2t + 1)$

b) $x(t)[\delta(t + \frac{3}{2}) - \delta(t - \frac{3}{2})]$

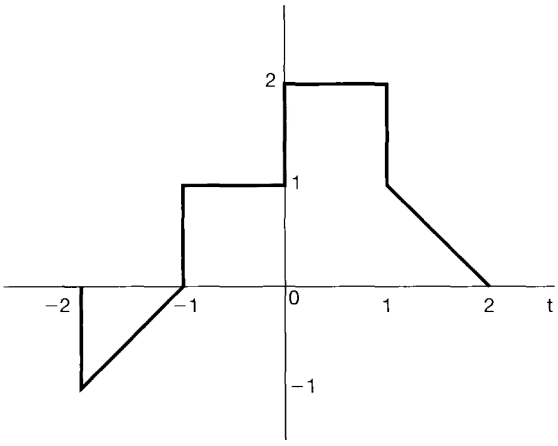

Figure 1: Problem 5

Problem 6

(Problem 1.22 (d, e, f) - Textbook)

A discrete-time signal is shown in Figure 2. Sketch and label carefully each of the following signals:

a) $x[3n+1]$

b) $x[n]u[3-n]$

c) $x[n-2]\delta[n-2]$

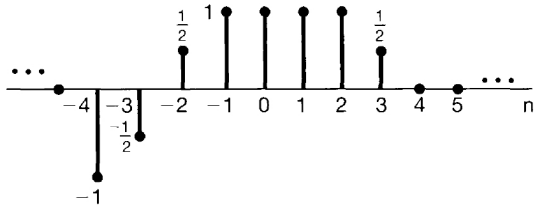

Figure 2: Problem 6

Problem 7

(Problem 1.25 (c, d, f) - Textbook)

Determine whether or not each of the following continuous-time signals is periodic. If the signal is periodic, determine its fundamental period.

c) $x(t) = [\cos(2t - \frac{\pi}{3})]^2$

d) $x(t) = \mathcal{E}v\{\cos(4\pi t)u(t)\}$

f) $x(t) = \sum_{n=-\infty}^{\infty} e^{-(2t-n)}u(2t-n)$

Problem 8

(Problem 1.26 (c, d) - Textbook)

Determine whether or not each of the following discrete-time signals is periodic. If the signal is periodic, determine its fundamental period.

a) $x[n] = \cos(\frac{\pi}{8}n^2)$

b) $x[n] = \cos(\frac{\pi}{2}n)\cos(\frac{\pi}{4}n)$

Textbook

Alan V. Oppenheim, Alan S. Willsky, and S. Hamid Nawab, Signals & Systems, 2nd Ed., Prentice-Hall, 1996 (ISBN 0-13-814757-4)