Fourier Series in Signal Processing

Your Name

1 Introduction

This document covers the application of Fourier series in signal processing.

2 Periodic Signals

2.1 Fourier Series Representation

2.2 Example Problem

Find the Fourier series representation of the periodic function $f(t) = t$ for $t \in [-\pi, \pi]$.

Solution

The Fourier series for a function $f(t)$ is given by:

$$f(t) = a_0 + \sum_{n=1}^{\infty} \left(a_n \cos(nt) + b_n \sin(nt) \right),$$

where

$$a_0 = \frac{1}{2\pi} \int_{-\pi}^{\pi} f(t)\, dt, \quad a_n = \frac{1}{\pi} \int_{-\pi}^{\pi} f(t) \cos(nt)\, dt, \quad b_n = \frac{1}{\pi} \int_{-\pi}^{\pi} f(t) \sin(nt)\, dt.$$

For $f(t) = t$, we find that $a_0 = 0$, $a_n = 0$, and

$$b_n = \frac{1}{\pi} \int_{-\pi}^{\pi} t \sin(nt)\, dt = \frac{2}{n}(-1)^{n+1}.$$

Thus, the Fourier series representation is:

$$f(t) = \sum_{n=1}^{\infty} \frac{2}{n}(-1)^{n+1} \sin(nt).$$