**The Fourier Transform and its Applications(EE261)**

**Chapter 1 Fourier Series**

**1.1 Introduction and Choices to Make**

Fourier analysis was originally concerned with representing and analyzing *periodic phenomena*, via *Fourier series*.

Extending those insights to *nonperiodic phenomena*, via *Fourier transform.*

One way of getting from Fourier series to the Fourier transform is to consider nonperiodic phenomena as a limiting case of periodic phenomena as the period tends to infinity.

Every signal has a spectrum and is determined by its spectrum. You can analyze the signal either in the time(or spatial) domain or in the frequency domain.

**1.2 Periodic Phenomena**

We think periodic phenomena according to whether they are *periodic in time* or *periodic in space*.

**1.2.1 Time and space**

Frequency ν, with dimension 1/sec and units Hz.

**1.2.2 More on spatial periodicity**

**1.3 Periodicity: Definitions ,Examples, and Things to Come**

A function *f(t) is periodic* of period *T* if there is a number *T > 0* such that

*f(t+T) = f(t)*

for all *t.* If there is such a *T* then the smallest one for which the equation holds is called the *fundamental period* of the function *f*. Every *integer* multiple of the fundamental period is also a period

*f(t+nT) = f(t)*, n = 0, ±1, ±2, . . .

The graph of *f* over any interval of length T is one *cycle*.

Is the sum of two periodic functions periodic?

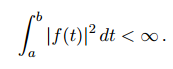
Answer is NO. E.g f(t) below is not a periodic function.

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**1.3.1 The view from above**

1. The functions that model the simplest periodic behavior,i.e.,sines and cosines. In practice,both in calculations and theory, we'll use the complex exponential instead of the sine and cosine separately.

2. The "geometry" of square integrable functions on a finite interval,i.e.,fuctions for which



That means a) least squares approximation; b) Orthogonality of the complex exponentials(复平面)

3. Eigenfunctions(特征函数) of linear operators(especially differential operators).