

2. Properties of Fourier Series (of

Course > Unit 1: Fourier Series > Period 2L)

> 10. Differentiating Fourier series

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10. Differentiating Fourier series

Key Insight: if a function is differentiable, you can simply differentiate its Fourier series term by term to obtain the Fourier series for the derivative.

Note:

There are many subtle, but important, questions in Fourier series that we will not cover here (but which courses such as 18.100 (Real Analysis) do, at least partially). For example: If I write some arbitrary Fourier series, how do I know if it comes from a differentiable function? If I differentiate term by term the Fourier series for a function that is not differentiable (like the square wave function), is the result the Fourier series for something?

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Example 10.1 The Fourier series for the period 2π triangle wave is:

$$\underline{g(t)} = \frac{\pi}{2} - \frac{4}{\pi} \left(\cos t + \frac{\cos 3t}{3^2} + \frac{\cos 5t}{5^2} + \cdots \right)$$

What is g'(t)?

Solution

Differentiating the Fourier series $\,g\left(t
ight)\,$ term-by-term gives

$$g'\left(t
ight)=rac{4}{\pi}igg(\sin t+rac{\sin 3t}{3}+rac{\sin 5t}{5}+\ldotsigg),$$

which is the Fourier series of the $\,2\pi$ -periodic square wave!

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10. Differentiating Fourier series

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Differentiating Fourier series
This page is perhaps a little too simplistic. Maybe it only applies to functions that are continuous and piecewise differentiable, but not functions with step discontinuities (like ...

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typo: Is the power 2 miss?

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