Università degli Studi di Padova

Lecture 11

Convolution and Fourier series in MatLab

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11.4 Fourier series in MatLab

Some insights

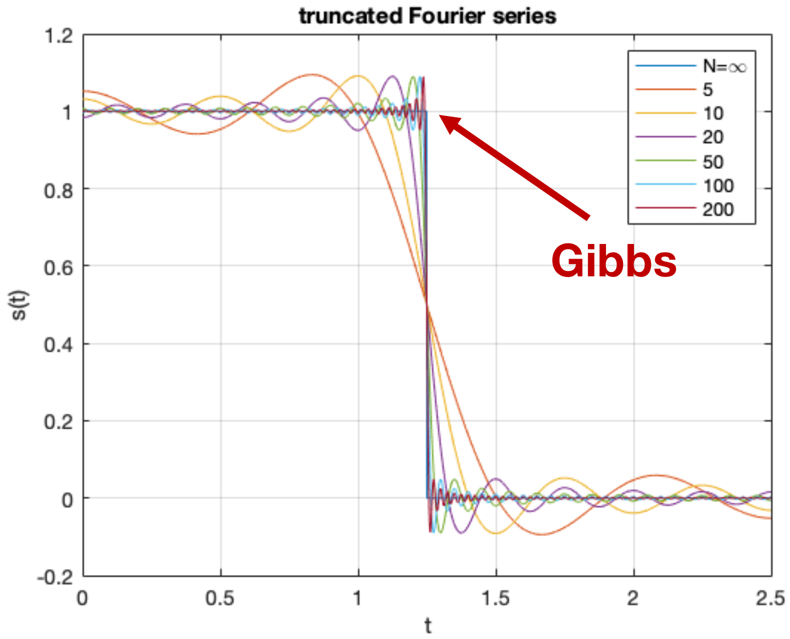
- The Gibbs phenomenon
- Approximating the coefficients via numerical integration

Square wave

And the Gibbs phenomenon

$$s_N(t) = \sum_{k=-N}^{N} a_k \, e^{jk\omega_0 t} \;, \quad \omega_0 = \frac{2\pi}{T_p} \;, \; a_k = d \; \mathrm{sinc}(kd)$$

truncated Fourier series

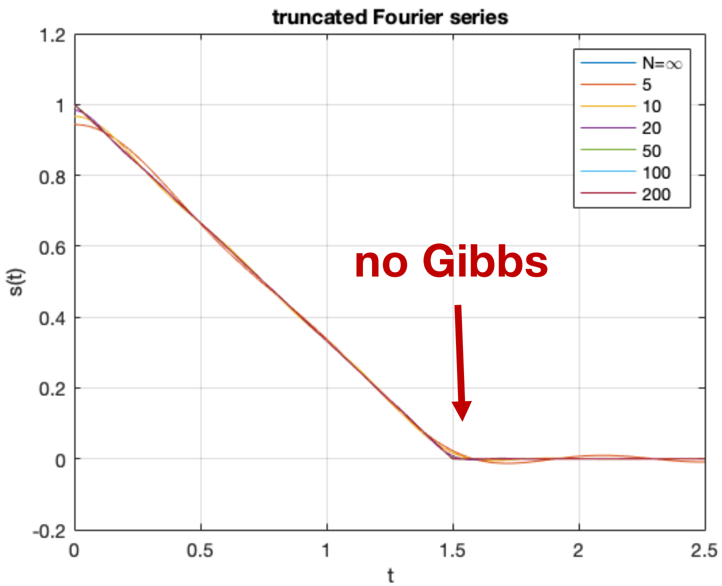


Triangular wave

And the absence of Gibbs phenomenon

$$s_N(t) = \sum_{k=-N}^{N} a_k \, e^{jk\omega_0 t} \;, \quad \omega_0 = \frac{2\pi}{T_p} \;, \; a_k = d \, \mathrm{sinc}^2(kd)$$

truncated Fourier series



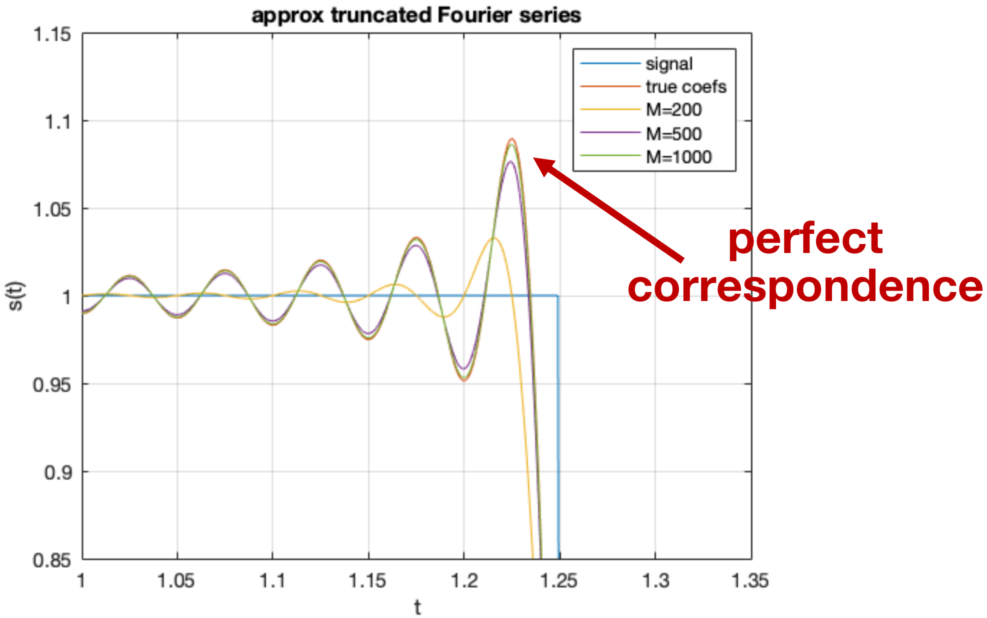
Square wave

Numerically evaluated coefficients

$$a_k = \frac{1}{T_p}\int_0^{T_p} s(t)e^{-jk\omega_0 t}dt \simeq b_k = \frac{1}{T_p}\cdot T\sum_{n=0}^{M-1} s(nT)\, e^{-jk\omega_0 nT}$$

$$T = T_p/M$$

approximated coefficients



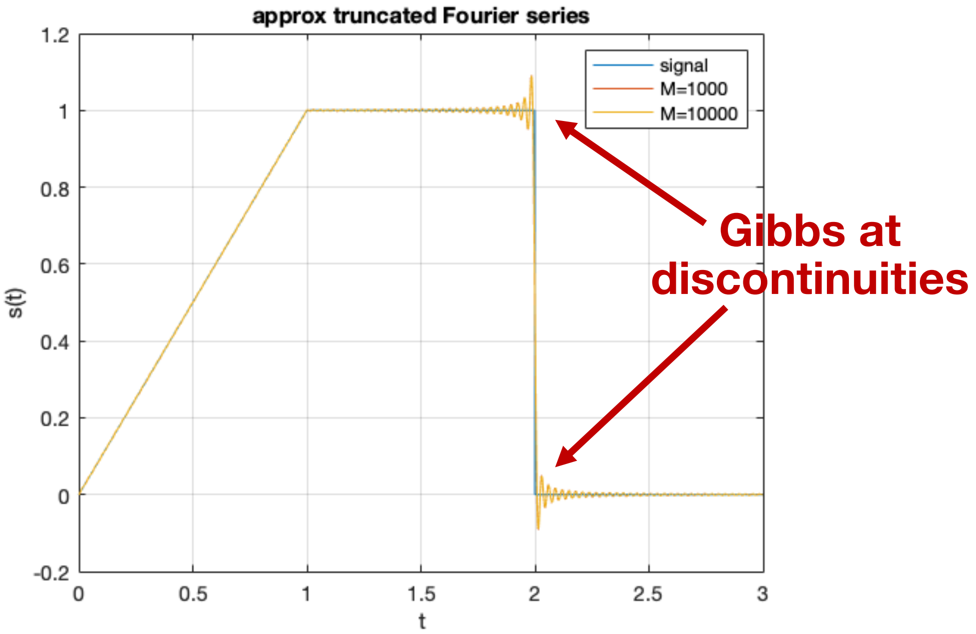
Generic wave

Numerically evaluated coefficients

$$a_k = \frac{1}{T_p}\int_0^{T_p} s(t)e^{-jk\omega_0 t}dt \simeq b_k = \frac{1}{T_p}\cdot T\sum_{n=0}^{M-1} s(nT)\,e^{-jk\omega_0 nT}$$

$$T = T_p/M$$

approximated coefficients



Exercises

On Fourier series

Observe the outcome of truncated Fourier series, and appreciate the presence of the **Gibbs' phenomenon** at discontinuities.

Practice yourself with **numerically evaluated** Fourier coefficients, to be able to represent any periodic signal through its (truncated) Fourier series

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