EECE 340 Project - Section 2.5 Connecting Fourier Series and Transforms

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Introduction

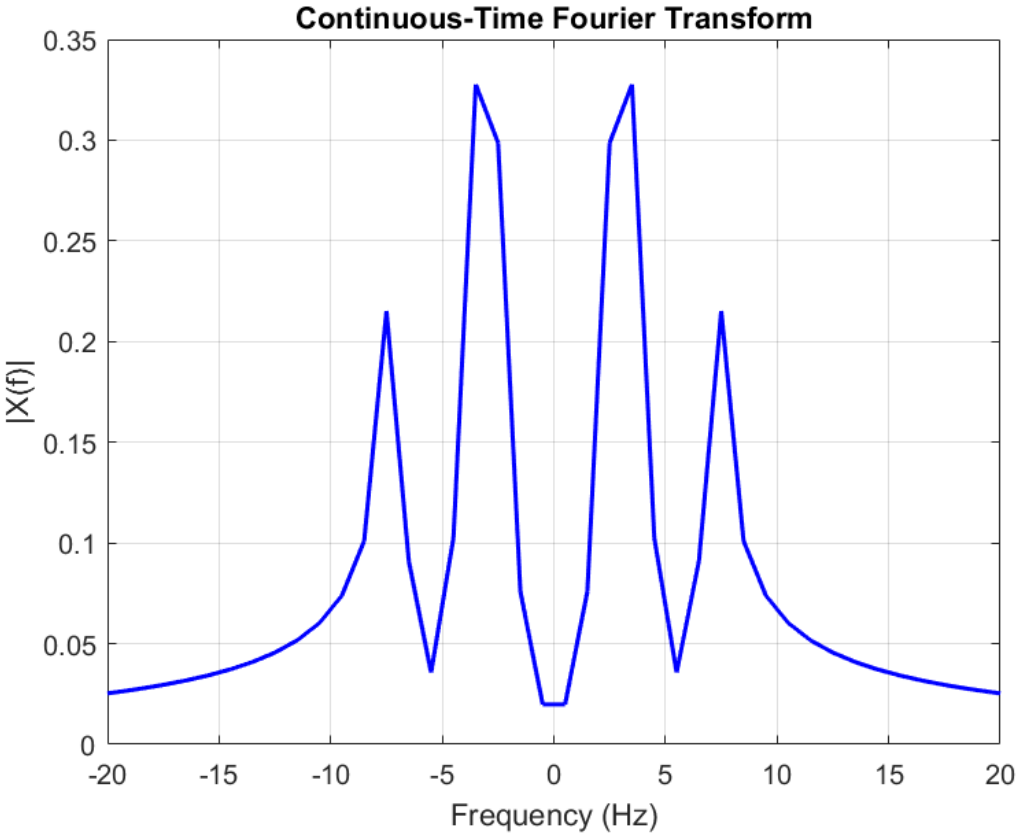
In this section, we demonstrate numerically that Fourier series coefficients can be obtained by sampling the Continuous-Time Fourier Transform (CTFT) at discrete frequencies corresponding to integer multiples of 1/T, where T is the period. This process is verified using a sample signal and the Fourier transform and sampling functions developed in this project.

MATLAB Files Description

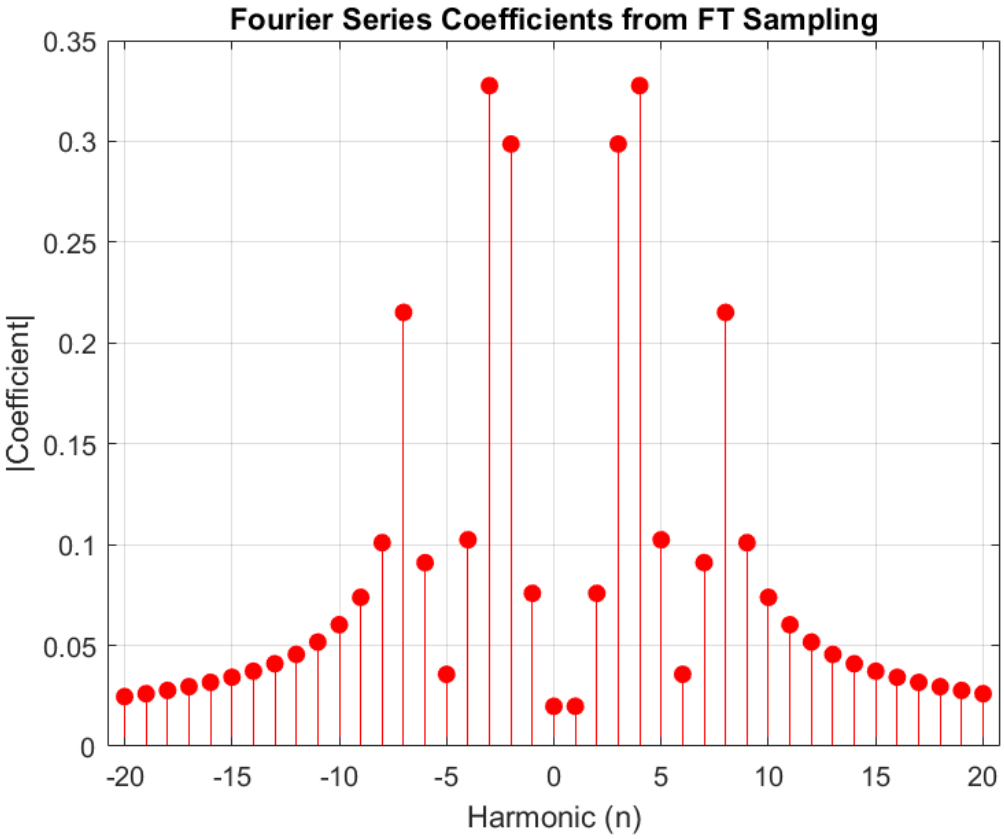
fs_vs_ft.m:
This script defines a composite periodic signal $x(t) = \cos(2\pi 3t) + 0.5\cos(2\pi 7t)$, computes its CTFT using the ftr.m function, samples the CTFT at harmonics of the fundamental frequency, and plots both the continuous Fourier transform and the sampled Fourier series coefficients.

Results

The Continuous-Time Fourier Transform (CTFT) of the signal was computed over a range of frequencies. It displayed clear peaks at ±3 Hz and ±7 Hz, corresponding to the frequencies present in the original signal.



By sampling the CTFT at integer multiples of 1/T (in this case, at harmonics n since T = 1 second), the obtained coefficients accurately captured the expected Fourier series structure: nonzero coefficients at n = ±3 and n = ±7 and approximately zero elsewhere.



Discussion

The results confirm that the Fourier series coefficients can indeed be recovered by sampling the CTFT at discrete frequencies corresponding to the harmonics of the period. This numerical verification aligns with the theoretical connection between the Fourier series and the Fourier transform.

Conclusion

By computing and sampling the Fourier Transform of a periodic signal, we successfully demonstrated that the Fourier series coefficients are obtained through appropriate sampling. This completes the numerical verification required in this section.