Signal processing lab

Two tones, one spectrum

A reproducible discrete Fourier transform example using a synthetic signal. The equations and plots are already saved; exporting does not require a LaTeX installation.

1. Construct the signal

Take 128 samples at 128 Hz. The input is the sum of an 8 Hz sine wave and a smaller 24 Hz sine wave.

$$x(t) = \sin(2\pi \cdot 8t) + 0.45\sin(2\pi \cdot 24t)$$

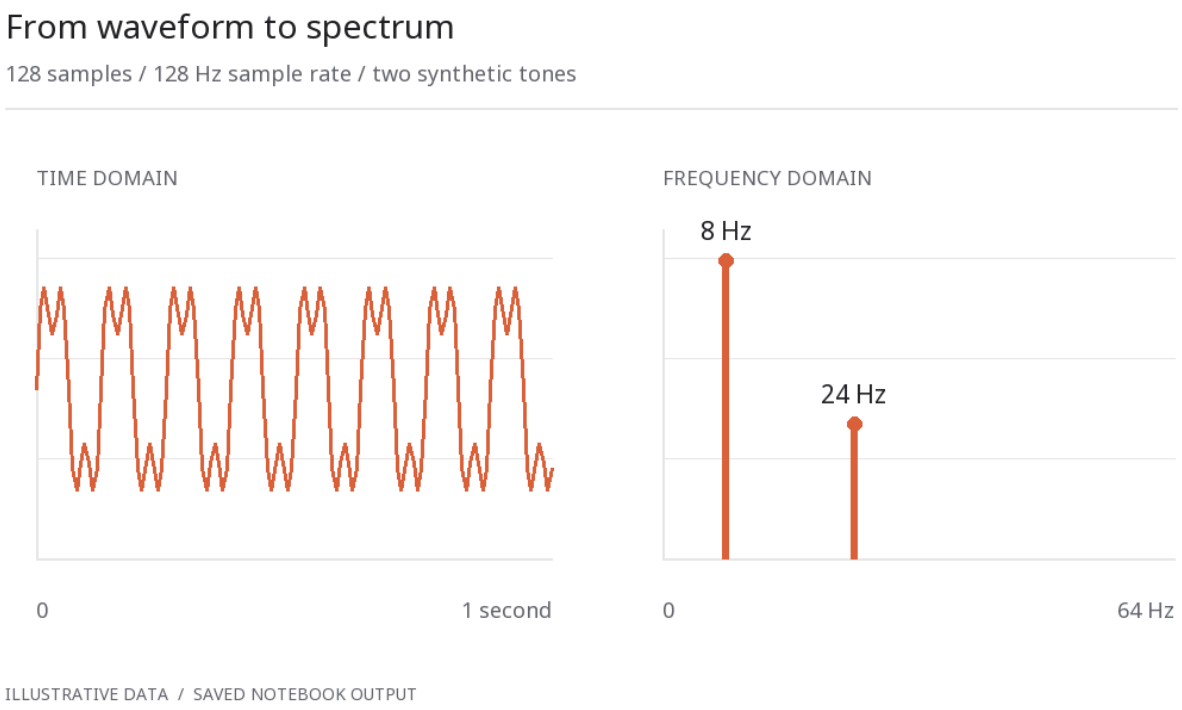
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Samples: 128; duration: 1.0 s
```

2. Frequency domain

The discrete Fourier transform separates the frequency components:

$$X_k = \sum_{n=0}^{N-1} x_n e^{-2\pi i k n / N}$$

For these integer-bin tones, the single-sided amplitude spectrum has peaks of 1.00 at 8 Hz and 0.45 at 24 Hz.



Frequency	Amplitude	Interpretation
8 Hz	1.00	Fundamental tone
24 Hz	0.45	Secondary tone

3. What changes with real signals?

Real measurements require attention to sampling, aliasing, noise and spectral leakage. These clean integer-bin tones intentionally avoid leakage so the calculation is easy to inspect.

Sharing tip: Full Notebook preserves the derivation and implementation. Formulas export as vector graphics.