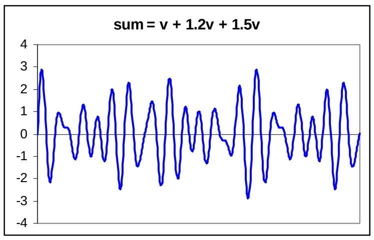
Harmonic Analysis and the FT

- All signals can be treated as a combination of periodic components (cosines and sines)
  - Resulting signal is a sum of individual waveforms.



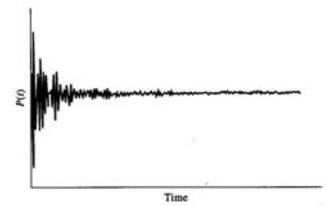


Figure 7-41 Time-domain signal of a source made up of several wavelengths.

  - Example applets
    http://www.chem.uoa.gr/Applets/Applet_Index2.htm

Fourier Transforms

- The FT allows conversion between time domain and frequency domain
  - t and 1/t are FT pairs (product is dimensionless)

$$f(\omega) = \int_{-\infty}^{+\infty} f(t)\left[\cos(\omega t) - i\sin(\omega t)\right]dt$$

$$f(t) = \int_{-\infty}^{+\infty} f(\omega)\left[\sin(\omega t) - i\cos(\omega t)\right]d\omega$$

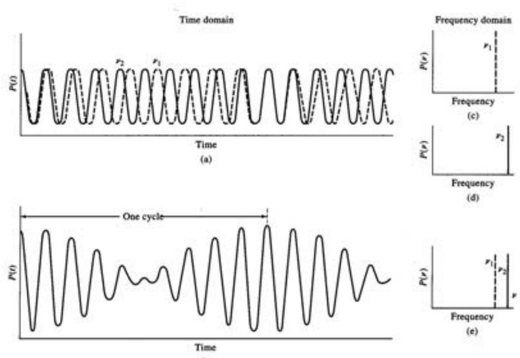


Figure 7-40 Illustrations of (1) time-domain plots (a) and (b) and (2) frequency-domain plots (c), (d), and (e).

Fourier Filtering

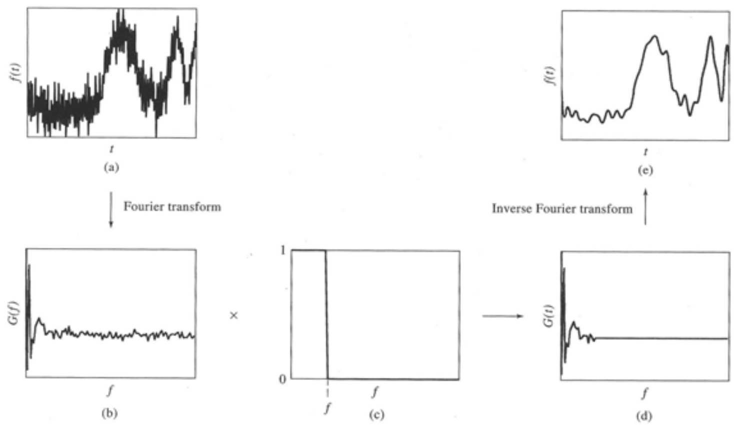


Figure 5-12 Digital filtering with the Fourier transform. (a) noisy spectral peak, (b) the frequency-domain spectrum of a resulting from the Fourier transformation, (c) low-pass digital-filter function, (d) product of (b) times (c). (e) the inverse Fourier transform of (d) with most of the high-frequency noise removed.

Practical Considerations

- Collecting continuous, infinite datsets is problematic!
  - Typically do just the opposite
  - Makes the math a little different

$$f(\omega) = \sum_{-\infty}^{\infty} f(t)\left[\cos(\omega t) - i\sin(\omega t)\right]$$

- Apodization