

- Short Class Outline
  - History and Definitions
  - Usage Applications
  - Fast Fourier Transform (FFT)
  - Amateur Radio Usage
  - Hardware Notes
  - Interesting Software
  - Questions

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- History & Definitions
  - Rather Old Mathematics
  - Change Domains (t to f)
  - Inverse Transform (f to t)
  - Periodic Waveforms
  - Usually an Integral or Series



History

- Joseph Fourier (1769-1830)
- Great Mathematical Insight
- Contributions by Poisson,
  Laplace & Gauss (1805)



#### Joseph Fourier (1769-1830)







#### Definitions

 Fourier Transform is a mathematical method to convert a time domain function to an identical frequency domain function.



#### FOURIER TRANSFORM

#### **The General Equation**

$$F(\omega) = \int_{-\infty}^{\infty} f(t)e^{-i\omega t} dt$$
  
$$f(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} F(\omega)e^{i\omega t} d\omega$$
  
HAIR RAISING



The General Equation Mathematicians are famous for trying to get the most bang for the least amount of symbols.

The Fourier equation is an Integral Transform - One of Many Similar Look on the Web

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## FOURIER TRANSFORM

#### The General Equation Good Example is Maxwell's Equations



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AKA Fourier Series

An Infinite Series Truncated to Desired Accuracy. Usually 10 Terms Results In a Good Approximation.



Change Signal Domains

- Periodic Waveforms
- Non-periodic Waveforms
- Before Computers, This was a Very Laborious Process.



#### Some Classic Examples

- Square Wave
- Triangle Wave
- Saw Tooth Wave
- Not Very Useful For Irregular Waveforms



- Enter the Computer
  - The FFT Process
  - Reinvented DFT by Cooley-Tukey for DSP (1965)
  - Algorithms Using "Filters"
    - The power of the DSP
  - The Power of the Sound Card



#### **Time vs Frequency Domains**





#### **Time vs Frequency Domains**







- Amateur Radio Usage
  Receiver Signal Processing
  Modulation Processing
  Digital Encoding (Fldigi)
  - Transmitting Audio Effects



#### Receiver DSP

- Noise Reduction
- Noise Blankers (Clicks)
- Pass-band Adjustments
- Audio Equalizing
- Notch Filters (Hum or QRM)



#### Hardware

- DSP Chip Sound Card
- DSP Chip Receiver
- Basically Very Fast Filters
- Do Things in The "f" domain



- Software Notes
  - Algorithms in Sound Cards
  - Generation of Encryption
  - Special Effects (Audacity)
  - Transmitting Audio EffectsBroke the Baud Rules



- Software Notes
  - Some Common Algorithms
  - DFT (Discrete FT)
  - Split Radix Algorithm
  - New Work Still Underway



#### Program Sources & Credits

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 Author is Kalid Azad.



- Wonderful Software
  - "Audacity" Free Software
  - Educational & Entertaining
  - Sound Card Understanding
  - Sound Track Manipulation
  - Demonstrate FFT Apps