

The background features abstract, thin black lines forming organic, wavy patterns that curve across the frame.

**GROUP 12**

# **FOURIER TRANSFORM**

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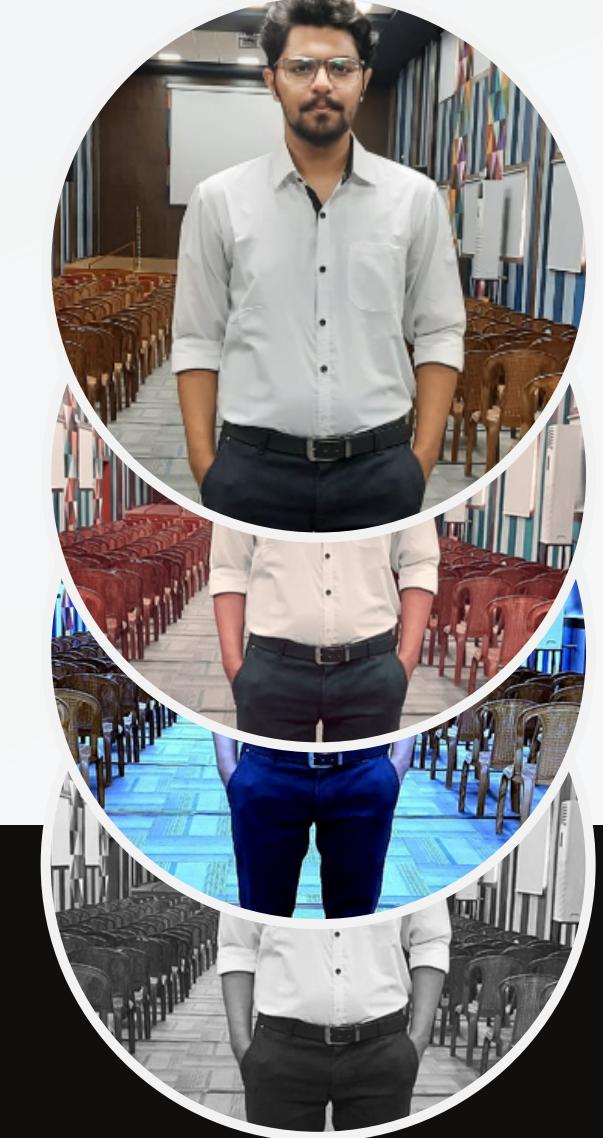
# CAN FOURIER TRANSFORM DO THIS?!



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# WHAT IS FOURIER TRANSFORM?

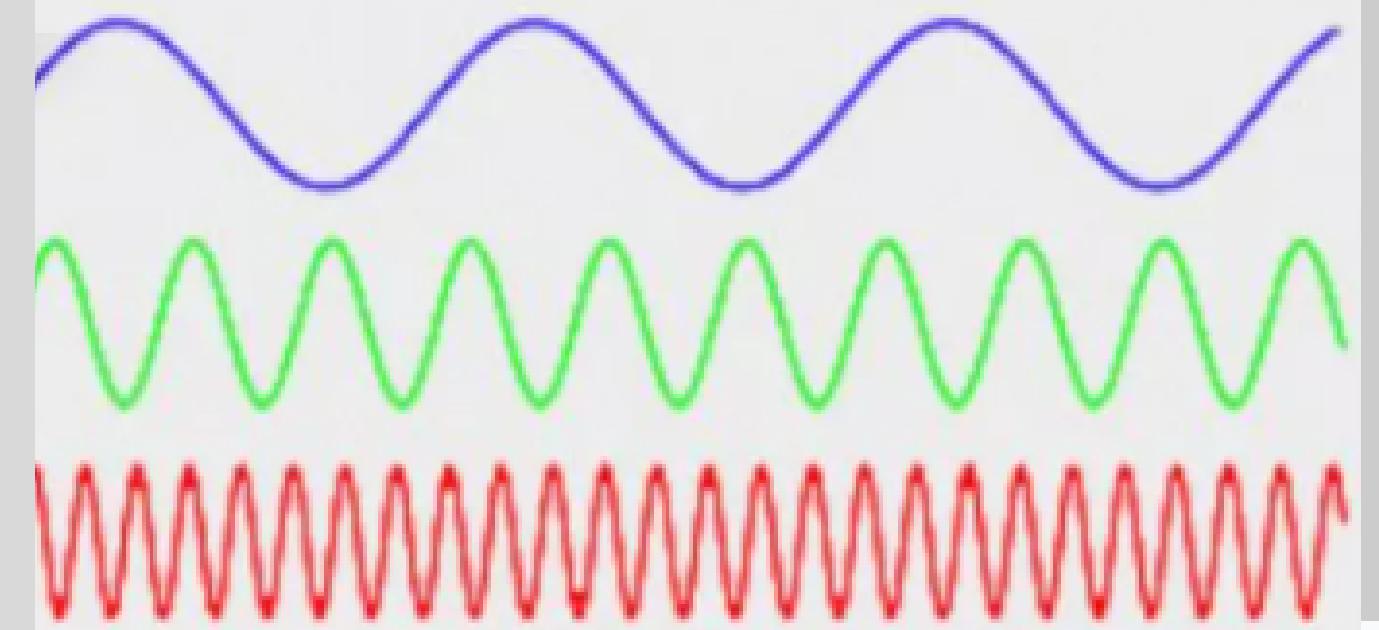
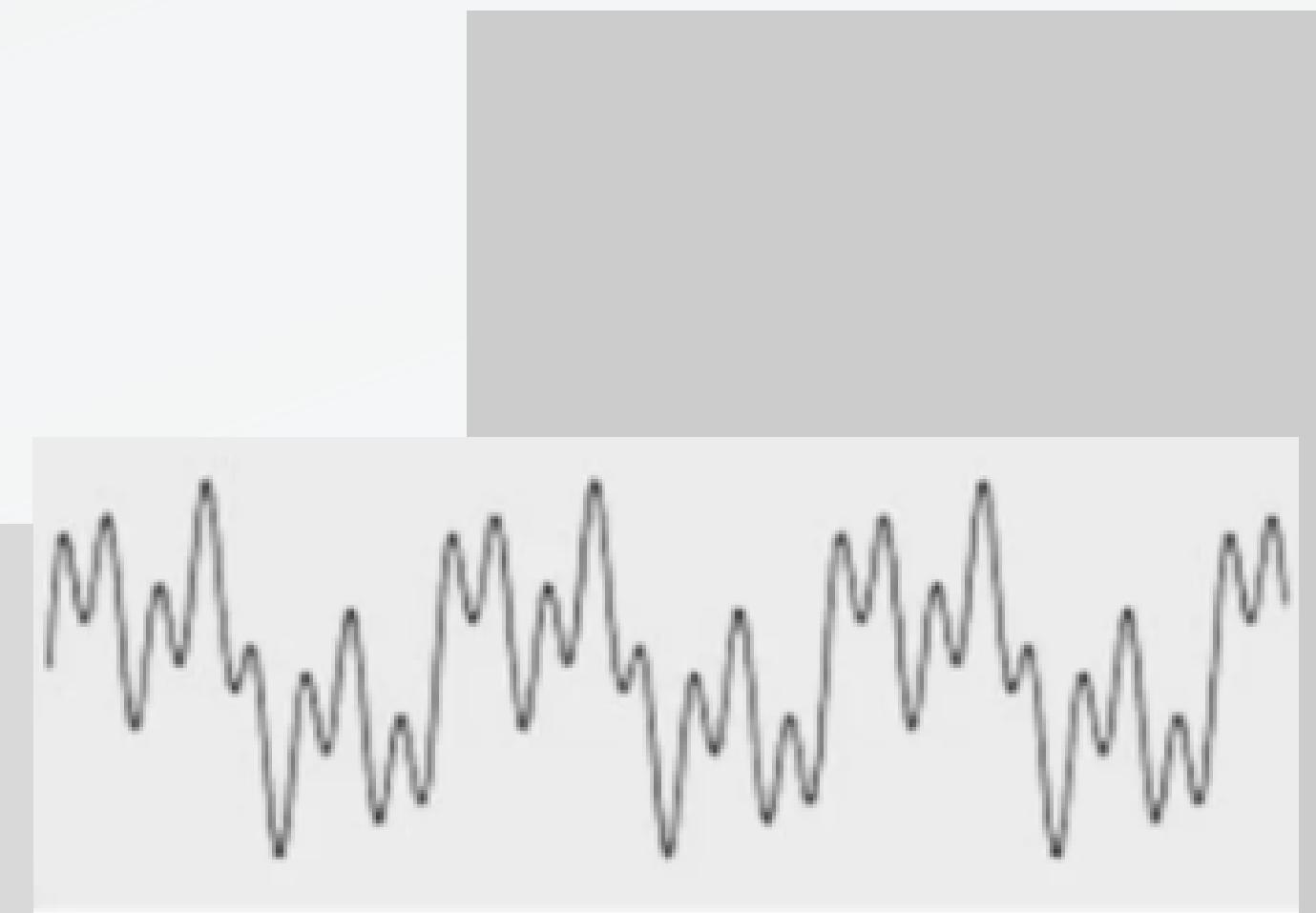


Fourier Transform is a mathematical technique that allows us to analyze and understand complex signals or functions by breaking them down into simpler components

$$F(\omega) = \int [f(t) * e^{-i\omega t}] dt$$

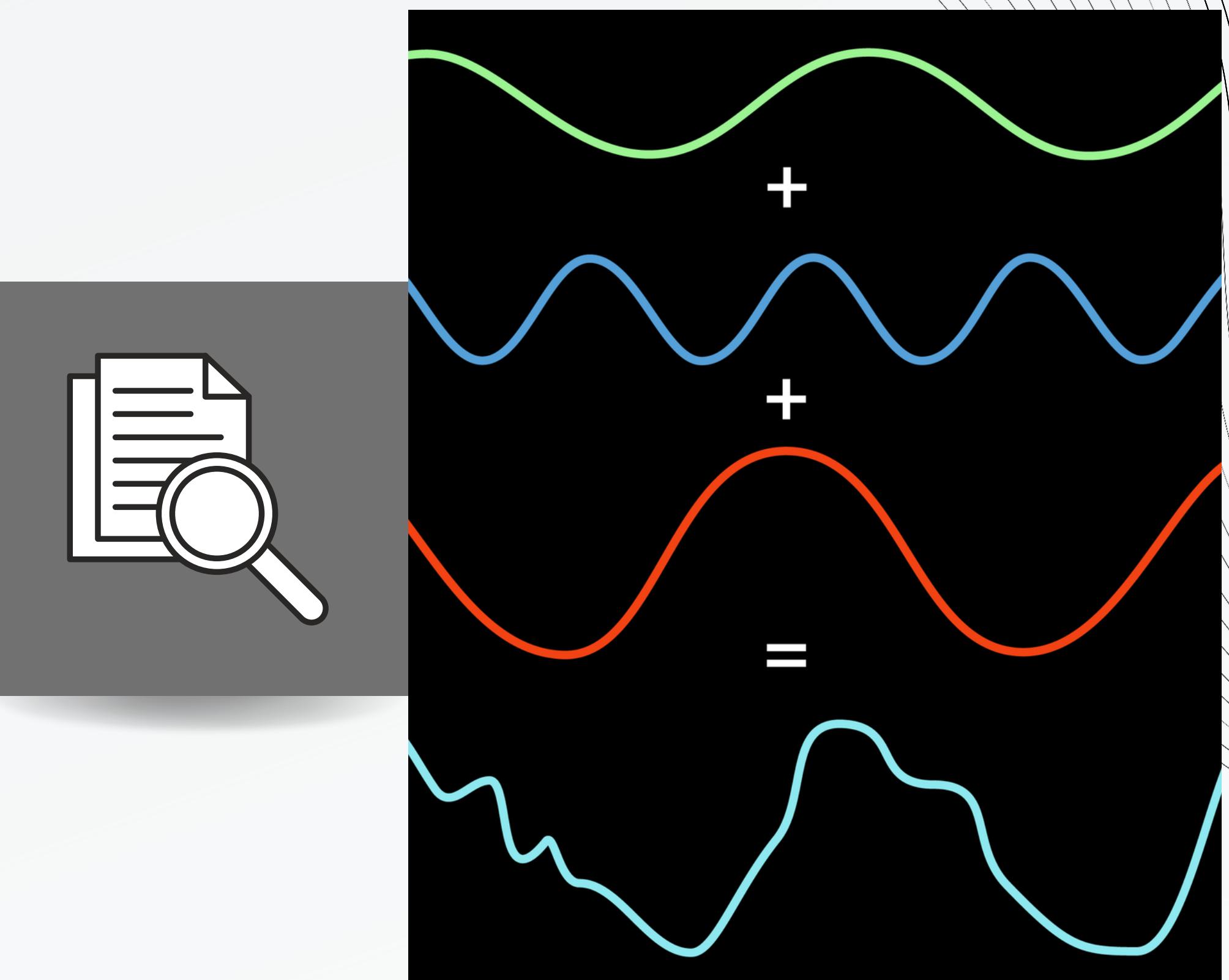


The Fourier transform allows us to analyze signals, images, and other data by examining their frequency content. By transforming data into the frequency domain, we can perform operations such as filtering, compression, and analysis that are more suitable or efficient in that domain.



# FOURIER ANALYSIS

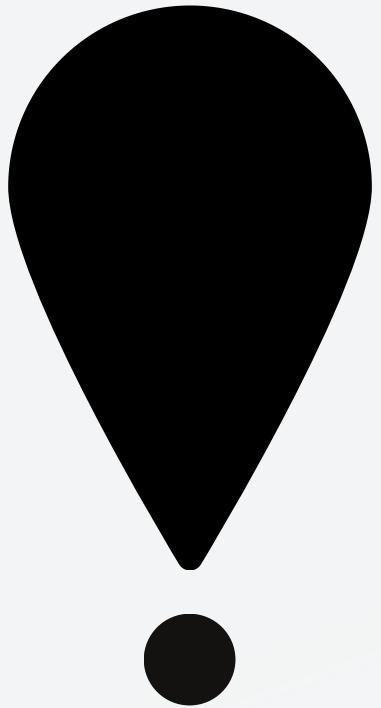
- A Fourier analysis is a mathematical method used to break down and transform a periodic function into a set of simpler functions.
- These simpler functions can then be summed and transformed back into the original form.
- A periodic function is a mathematical relationship between a quantity and a variable or variables whose relative values consistently repeat over some regular period of time.



# HOW DID IT CAME INTO PICTURE?

- Invented in the early 19th century, French physicist and mathematician **Joseph Fourier** transformed the partial differentiation equation representing the propagation of heat into a series of simpler trigonometric wave functions.  
(Ex. sines and cosines )
- These wave functions could be superimposed to reconstitute the original function, thereby providing a simpler, general solution to the problem.





## DID YOU KNOW?

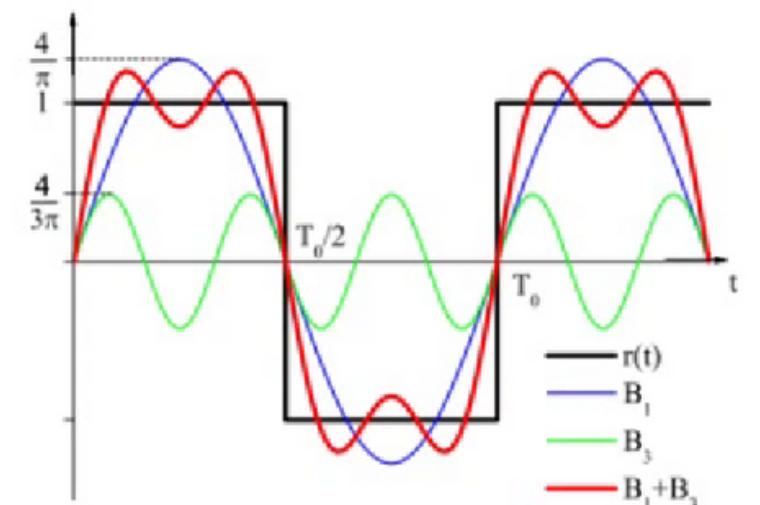


$$\sigma_x \sigma_p \geq \frac{\hbar}{2}$$

One of the weirdest results in quantum physics is the Heisenberg Uncertainty Principle, that states for a given particle the more precisely its position is defined, the more uncertain its momentum is and vice versa.

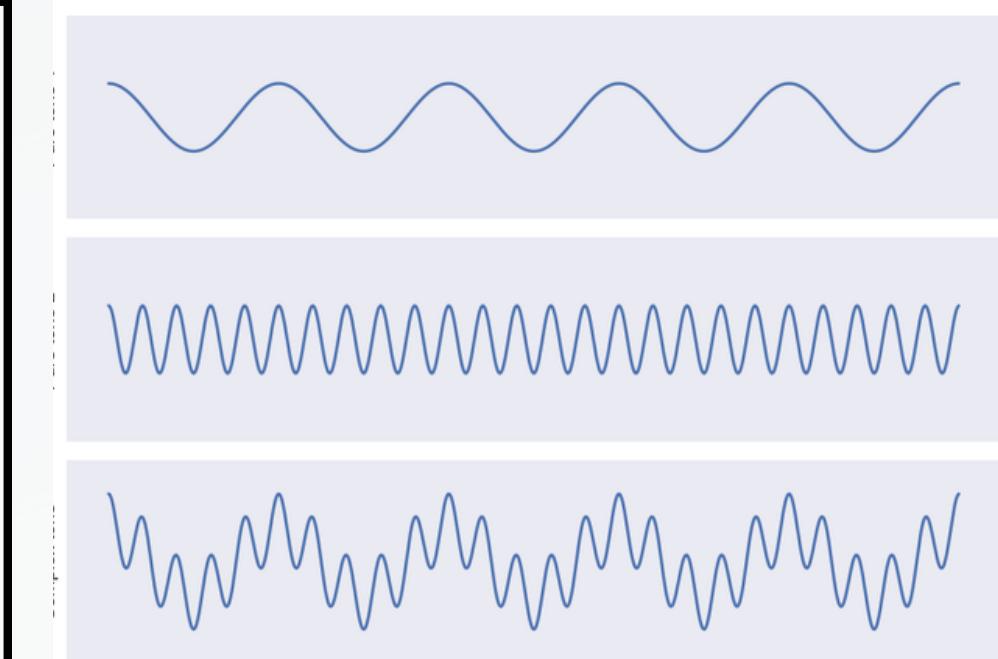
**Fourier Transformations is essentially a theorem for Heisenberg Uncertainty Principle.**

# FOURIER ANALYSIS



- A Fourier Analysis begins with a Fourier transform.
- The Fourier Transform breaks down, or **decomposes**, a single, more complicated periodic wave function into a set of simpler elements called a "Fourier Series" that takes the form of sine and cosine waves or complex exponential equations.

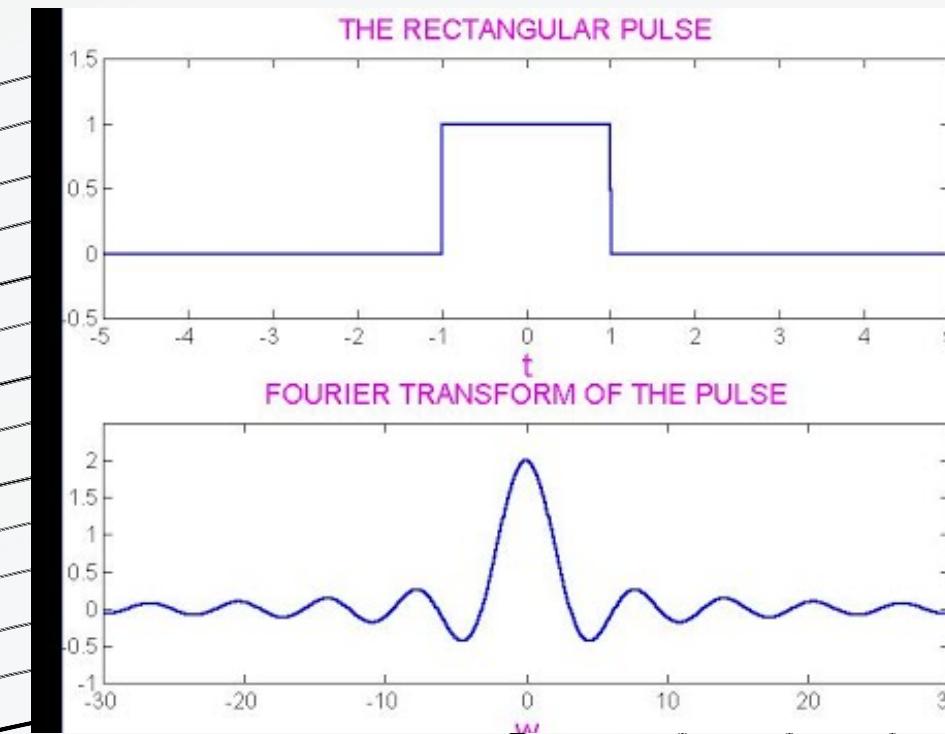
- These can then be solved using simpler mathematics and superimposed, or recombined, to yield a solution to the original function via linear combination.
- The decomposed elements in a Fourier Series are sometimes referred to as "harmonics".
- Narrowly defined, Fourier Analysis refers to the process of decomposing the original function into a series of simpler components.



# FOURIER TRANSFORM COMMON APPLICATION

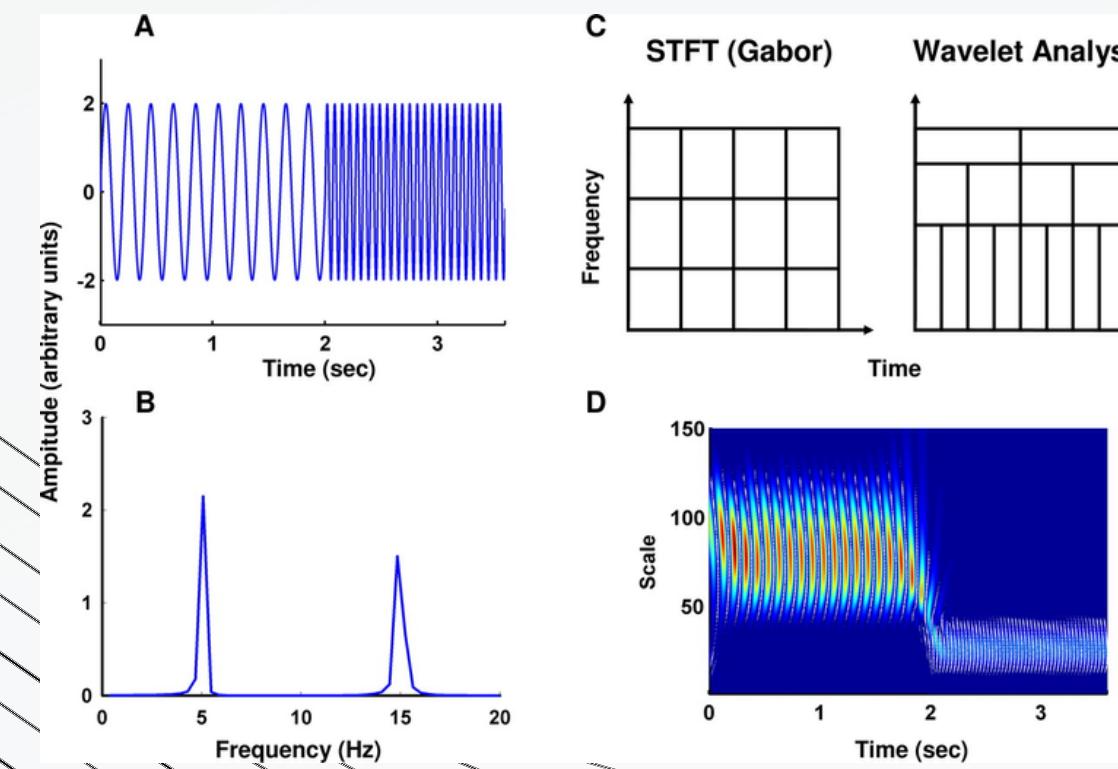
## Singnal analysis

THEY CAN DECOMPOSE A COMPLEX SIGNAL INTO ITS CONSTITUENT FREQUENCIES, REVEALING IMPORTANT INFORMATION ABOUT THE SIGNAL'S BEHAVIOR AND CHARACTERISTICS.



## Spectrum Analysis

THIS HELPS IDENTIFY THE DOMINANT FREQUENCIES PRESENT IN THE SIGNAL AND THEIR RESPECTIVE AMPLITUDES, ENABLING TASKS LIKE FILTERING, NOISE REMOVAL, AND FEATURE EXTRACTION.



## Data Compression

IT PLAY A FUNDAMENTAL ROLE IN DATA COMPRESSION BY TRANSFORMING THE DATA INTO THE FREQUENCY DOMAIN. IT BECOMES POSSIBLE TO DISCARD OR QUANTIZE LESS IMPORTANT FREQUENCY COMPONENTS

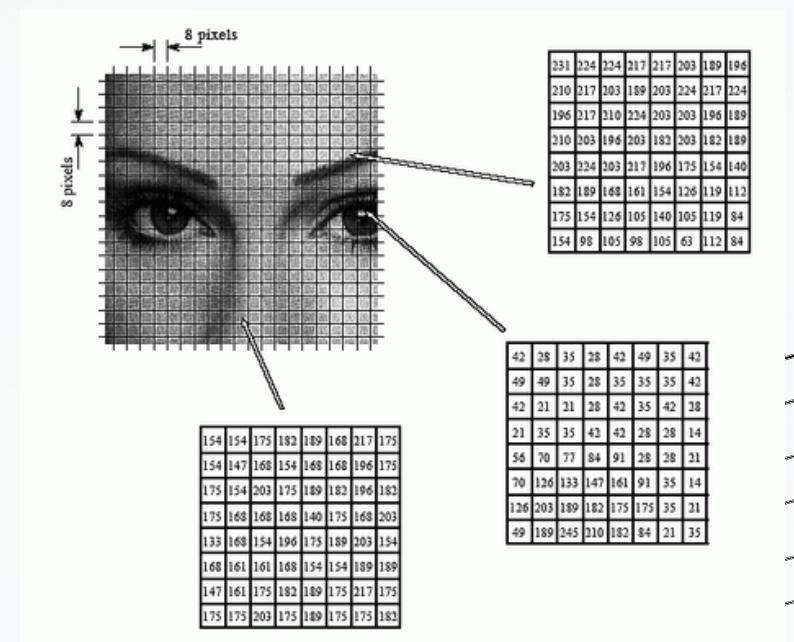
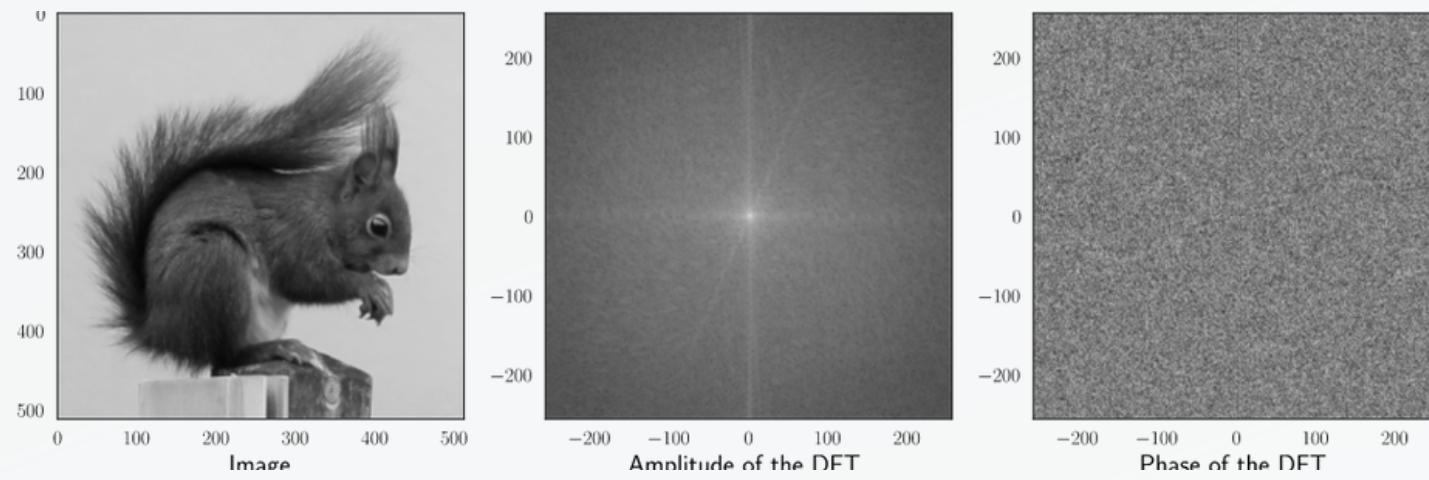


FIGURE 27-9  
JPEG image division. JPEG transform compression starts by breaking the image into  $8 \times 8$  groups, each containing 64 pixels. Three of these  $8 \times 8$  groups are enlarged in this figure, showing the values of the individual pixels, a single byte value between 0 and 255.

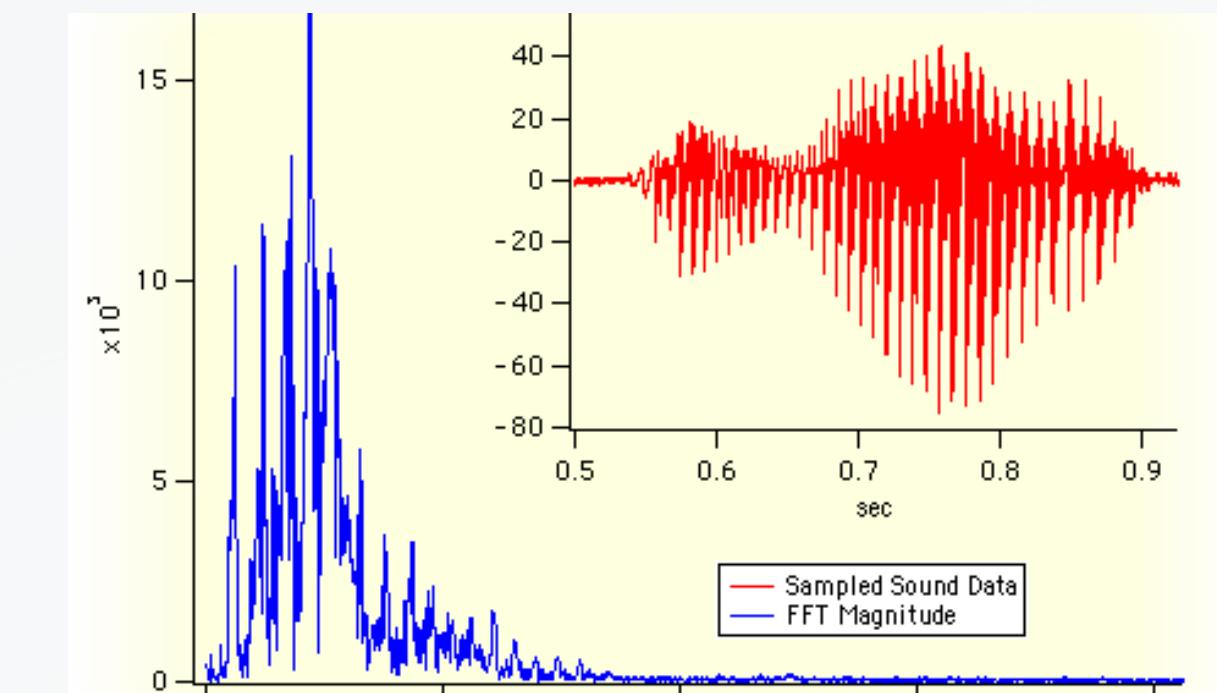
## Image Processing

FOURIER TRANSFORMS ARE EXTENSIVELY USED IN IMAGE PROCESSING TASKS. THEY CAN HELP ANALYZE THE SPATIAL FREQUENCY CONTENT OF IMAGES, IDENTIFY PATTERNS OR STRUCTURES, PERFORM IMAGE FILTERING, ENHANCE IMAGE QUALITY, AND IMPLEMENT OPERATIONS LIKE IMAGE COMPRESSION OR DEBLURRING.



## Audio Processing

FOURIER TRANSFORMS ARE WIDELY USED IN AUDIO PROCESSING APPLICATIONS. THEY ENABLE TASKS SUCH AS AUDIO EQUALIZATION, NOISE REDUCTION, PITCH SHIFTING, AUDIO SYNTHESIS, AND EFFECTS LIKE REVERB OR MODULATION.





# CODE DEMONSTRATION

**THANK  
YOU**

