UNDERSTANDING FOURIER ANALYSIS

Fourier analysis equation:

$$S(f) = \int_{-\infty}^{\infty} s(t) \cdot e^{-j 2\pi f t} \, dt$$

What this equation does:

This equation takes the time-domain function $s(t)$ and determines its spectral components:

if $s(t)$ is ...		$S(f)$ is ...
pressure / time	⟷	amount of sound at each pitch
EM field intensity / time	⟷	frequency (color) at each
waves	⟷	amount of each wave at each frequency.

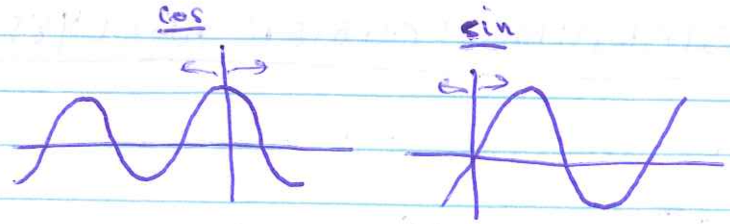
Basically, we're trying to see, not how much of a function exists at each point, but how much sine/cosine we would need to approximate it.

How it works:

Let's break the equation down to parts:

$e^{-j 2\pi f t}$ is the same as saying $(\cos(2\pi f t) + j \sin(2\pi f t))$

in other words, the complex exponential is giving us a way of representing a sinuosoidal wave of <u>any</u> phase.

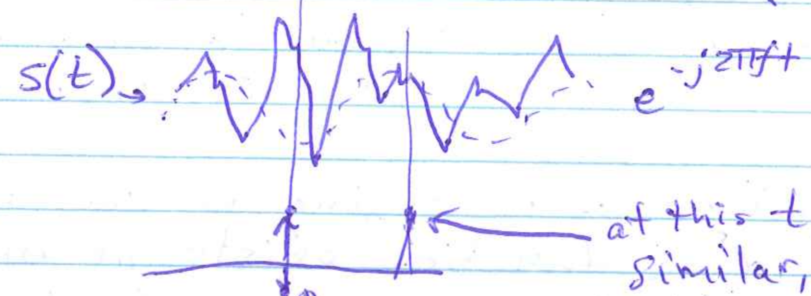


complex ⟵ ⟶ the complex exponential allows us to line up the wave with any starting point.

Next, the:

$$s(t) \cdot e^{-j2\pi ft}$$

this is saying, at each point, what's the "overlap"



at this t, the two are similar, so it does help us. Add it in!

at this t, they go in different directions, so the frequency doesn't give us what we want, so subtract it.

Integrating this multiplication means we total up the amount this frequency helps and hinders. If it's positive, we want to have some of this frequency. If negative, we want to have some of the inverse.