DSP (Day-3)

Fourier Transforms:

The function F(S); defined by

$$F(s) = \int_{-\infty}^{\infty} f(x)\, e^{isx}\, dx.$$

is called as fourier transform of f(x). Also the function f(x) defined by

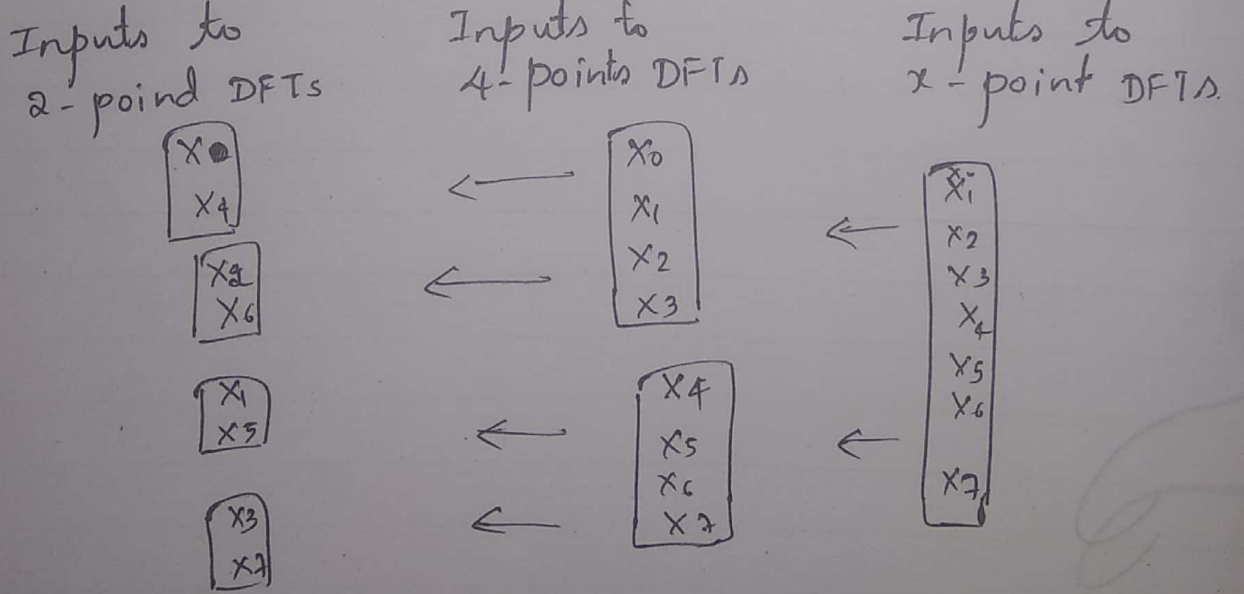
$$f(x) = \frac{1}{2\pi} \int_{-\infty}^{\infty} F(s)\, e^{jsx}\, ds$$

is called inverse fourier transform of F(S) or inversion formula.

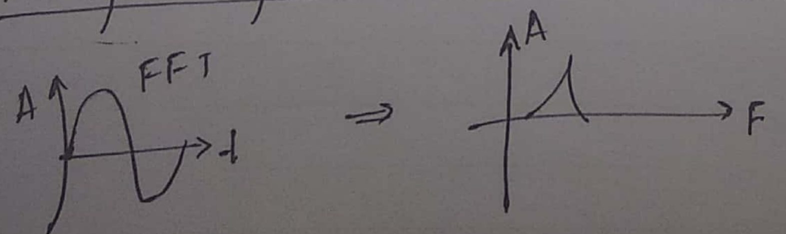
* FFT

$$X_p = \sum_{n=0}^{N-1} x_n W_N^{pn}, \quad W_N \triangleq e^{-j\frac{2\pi}{N}}, \quad 0 \le p \le N-1$$

$$X_0 = x_0 + x_1 + x_2 + x_3$$



* FFT fast fourier transform Matlab.



FIR & IIR filters.

FIR filter.

- Consider system described by the transfer function.

$$H(z) = \frac{b_3 z^3 + b_2 z^2 + b_1 z + b_0}{z^3}$$

- The corresponding Diff eqn

$$y[k] = b_3 f[k] + b_2 f[k-1] + b_1 f[k-2] + b_0 f[k-3]$$

Show the current output is a function of current (past i/p)

- FIR filters only have poles at the origin.

* We want to design equivalent Digital system.
continuous - time system.

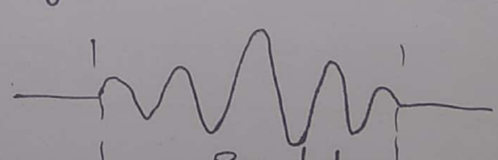
$$x(t) \longrightarrow \boxed{H(\omega)} \longrightarrow y(t)$$

$$X(t) \longrightarrow \boxed{A/D} \xrightarrow{X(k)} \boxed{H(z)} \xrightarrow{Y(k)} \boxed{D/A} \longrightarrow y(t)$$

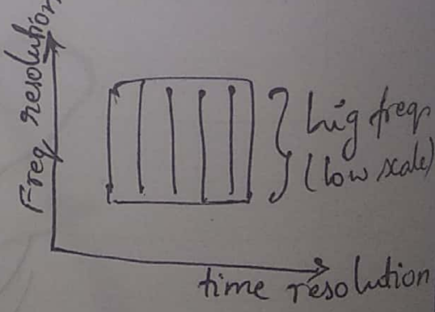
* FIR and IIR using FDA tool in matlab.

FT

wavelet Transform.



Resolution

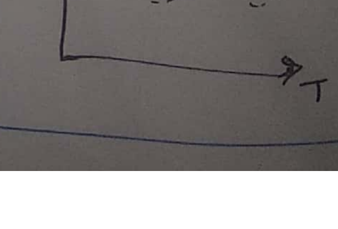


* CWT & DWT

Fourier series.

$$f(t) = \frac{1}{2}a_0 + \sum_{K=1}^{\infty} (a_k \cos 2\pi K t + b_k \sin 2\pi K t)$$

$$X(F) = \int_{-\infty}^{\infty} x(t)\, e^{-j2\pi} F(t)\, dt$$



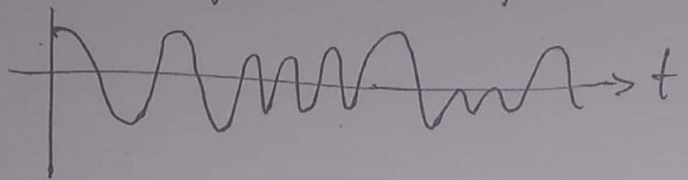
Discrete fourier transform.

continuous $X(F) = \int_{-\infty}^{\infty} x(t)\, e^{-j2\pi ft}\, dt$

discrete $X_K = \sum_{n=0}^{N-1} x_n \cdot e^{-j2\pi kn/N}$

~~equ~~ evaluating at n of N samples.

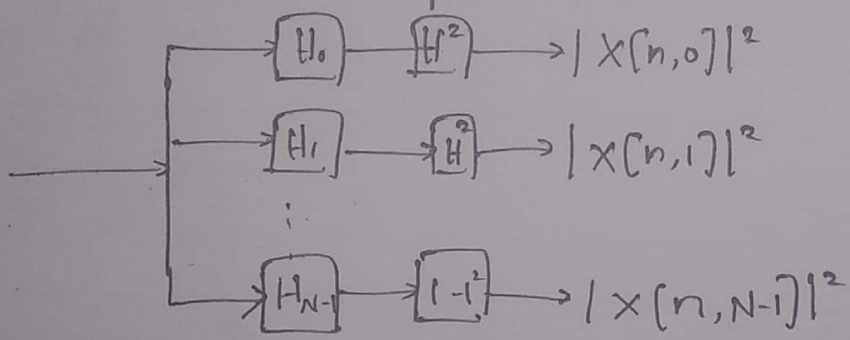
* Short time fourier transform & spectogram.



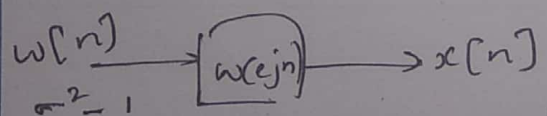
Inverse STFT

$$x(n+m) = \frac{1}{N\, w[m]} \sum_{K=0}^{N-1} X(n,K)\, e^{j\frac{2\pi}{N} km}.$$

Filter bank interpretation



Welch's method & windowing.



$S_{xx}(\omega) = |H(e^{j\omega})|^2$

$S_{xx}(f) = |H(e^{j2\pi f/f_s})|^2$

Python:

* programs.