4/16/25

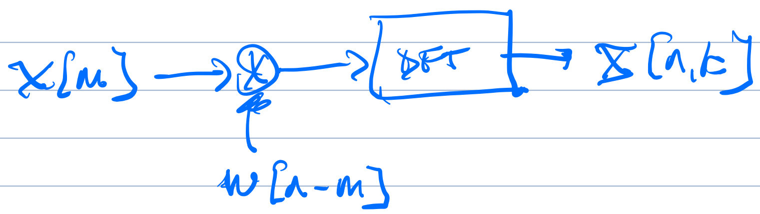
INTRO TO SHORT-TIME FOURIER TRANSFORMS (STFTs)

SOURCES:

* ADSP CLASS NOTES
* NAWAB & QUATIERI CHAPTER IN LIM + OPPENHEIM
* OS&SP 10.3-10.4 (DIFFERENT NOTATION)
* RABINER & SCHAFER

FOURIER TRANSFORM IMPLEMENTATION OF STFT

$$X[n,k] = \sum_{m} x[m]\, w[n-m]\, e^{-j\omega_k m} \qquad \omega_k = \frac{2\pi k}{N}$$

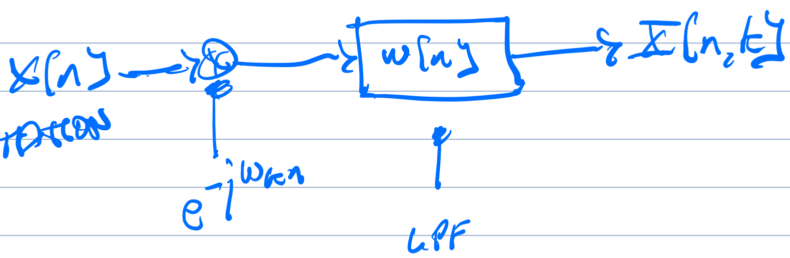


OTHER IMPLEMENTATIONS OF STFT...

$$X[n,k] = \sum_{m=-\infty}^{\infty} x[m]\, w[n-m]\, e^{-j\omega_k m}$$

$$= \sum_{m=-\infty}^{\infty} w[n-m] \left(x[m]\, e^{-j\omega_k m} \right) = w[n] * x[n] e^{-j\omega_k n}$$

LOWPASS FILTER IMPLEMENTATION

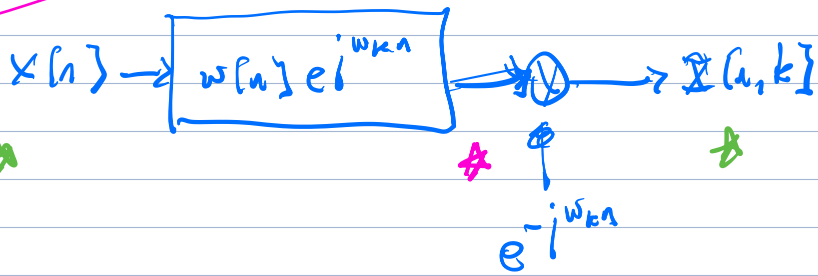


$$X[n,k] = \sum_{m=-\infty}^{\infty} x[m]\, w[n-m]\, e^{-j\omega_k m} \qquad e^{j\omega_k n}\, e^{-j\omega_k n}$$

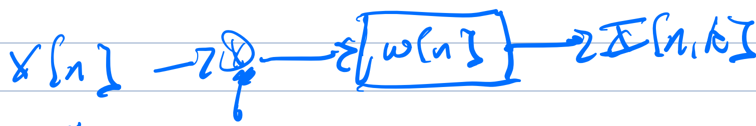
$$= e^{-j\omega_k n} \sum_{m=-\infty}^{\infty} x[m]\left(w[n-m]\, e^{j\omega_k (n-m)} \right)$$

$$\tilde{X}[n,k] \quad x[n] * w[n]\, e^{j\omega_k n}$$

BANDPASS FILTER IMPLEMENTATION

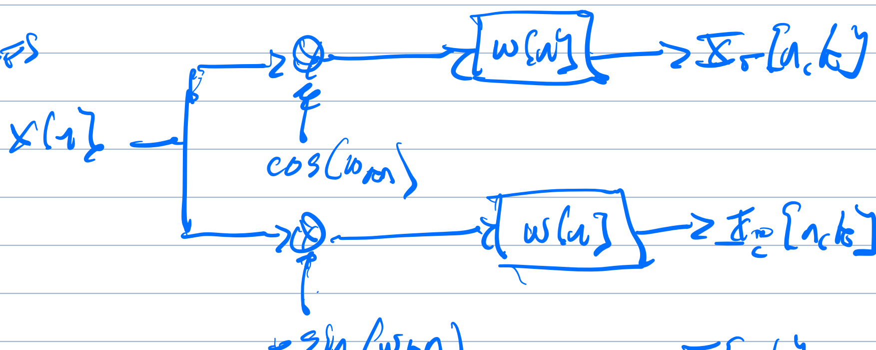


LP IMPLEMENTATION

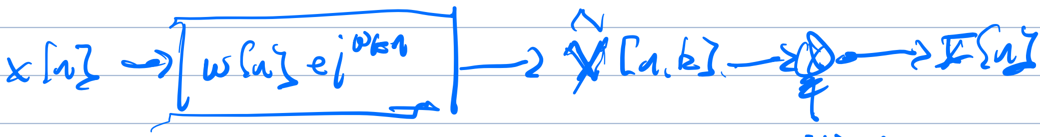


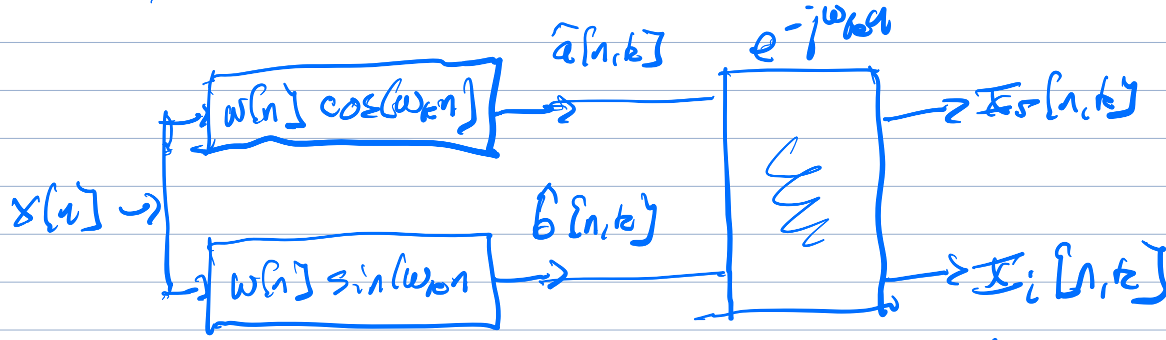
$$e^{-j\omega_k n} = \cos(\omega_k n) - j\sin(\omega_k n)$$

IMPLEMENTATION WITH REAL COEFFS



$$X[n,k] = X_r[n,k] + j X_i[n,k]$$





$$X[n,k] = \sqrt{a^2[n,k] + b^2[n,k]}$$