

Discrete Fourier Transform (DFT)



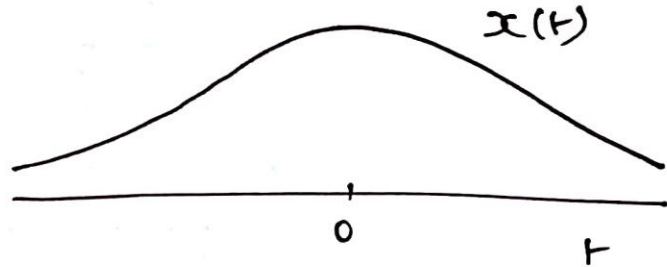
Fourier Transform Relations

✓ CTFP $X(\omega) = \int_{-\infty}^{\infty} x(t) e^{-j\omega t} dt$; $x(t) = \int_{-\infty}^{\infty} X(\omega) e^{j\omega t} d\omega$

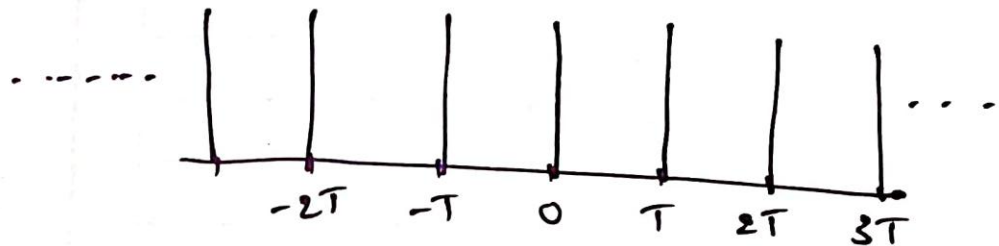
✓ DTFT $X(\omega) = \sum_{m=-\infty}^{\infty} x(m) e^{-j\omega m}$; $x(m) = \frac{1}{2\pi} \int_{-\pi}^{\pi} X(\omega) e^{j\omega m} d\omega$

✓ DFT $X(k) = \sum_{n=0}^{N-1} x(n) e^{-j\frac{2\pi}{N}nk}$; $x(n) = \frac{1}{N} \sum_{k=0}^{N-1} X(k) e^{j\frac{2\pi}{N}nk}$

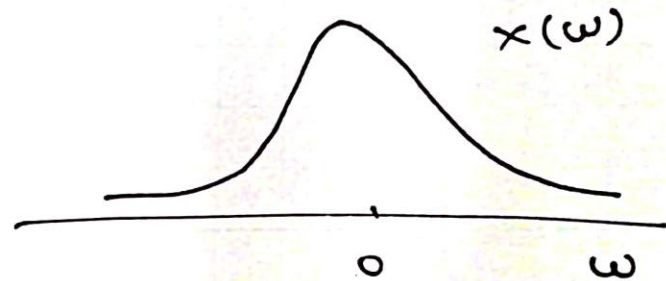
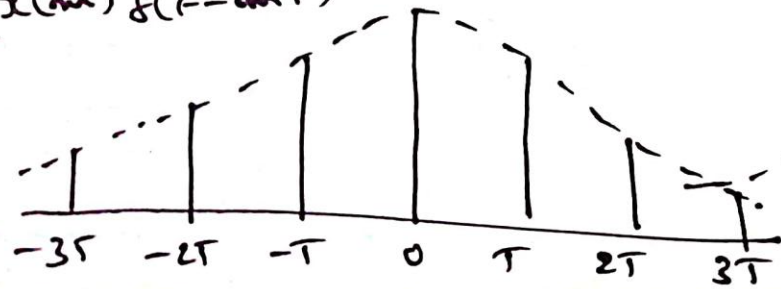
Graphical Interpretation of DFT Relations



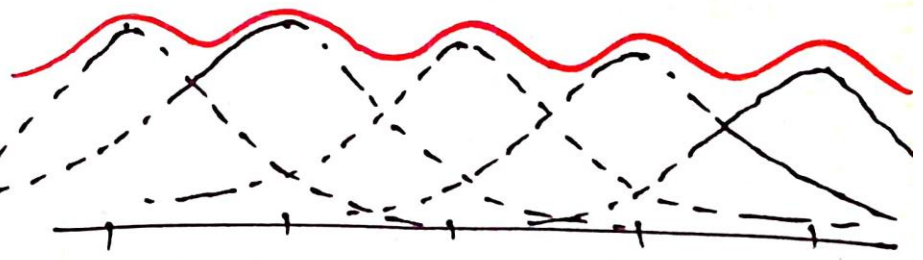
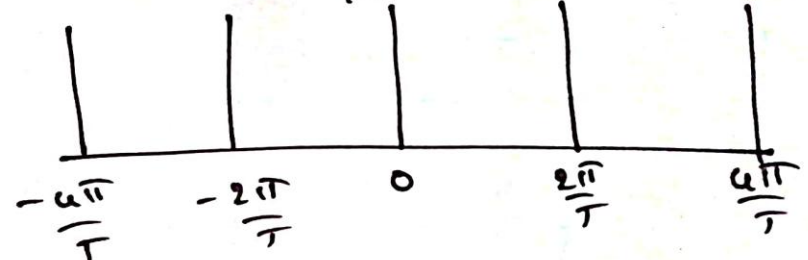
$$\sum_{m=-\infty}^{\infty} f(t - mT)$$



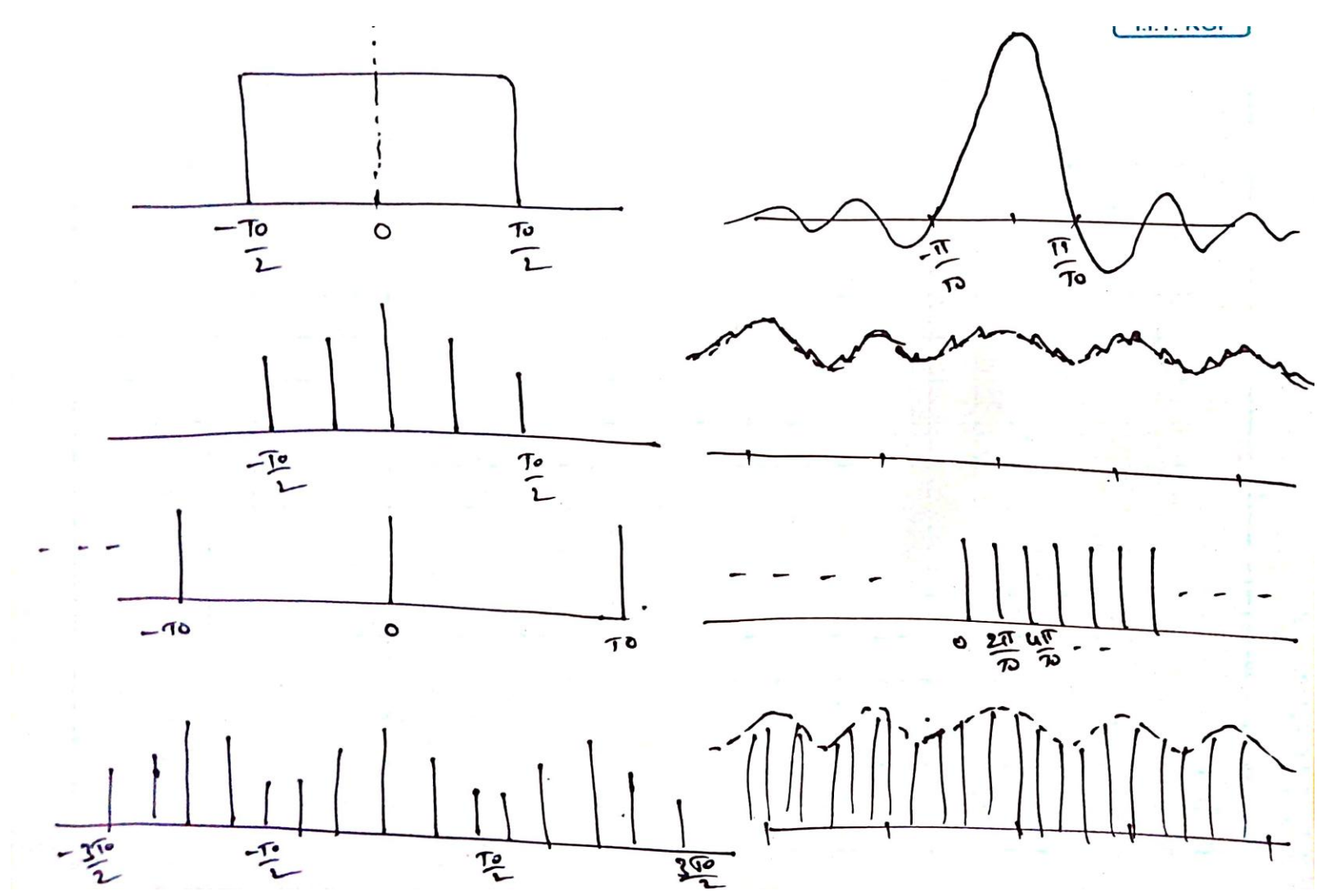
$$\sum_m x(mT) \delta(t - mT)$$



$$\frac{2\pi}{T} \sum_{k=-\infty}^{\infty} f(\omega - \frac{2\pi}{T} k)$$



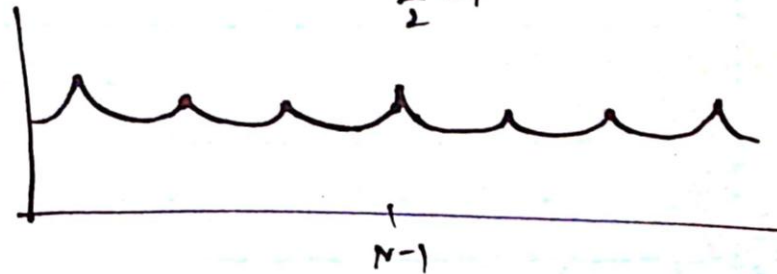
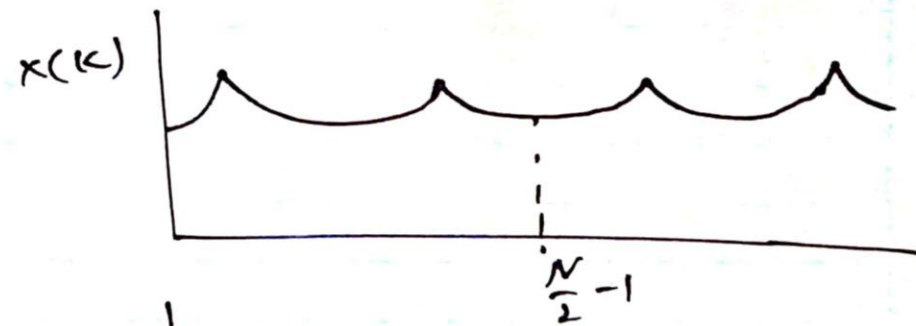
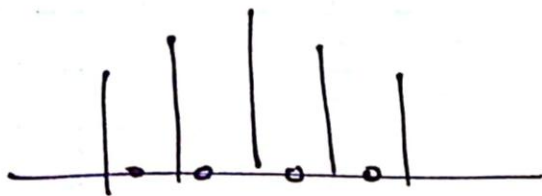
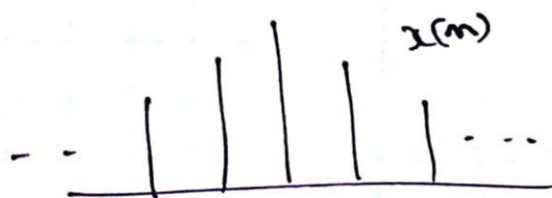
Graphical Interpretation of DFT Relations



Important Properties of DFT

① Symmetry & Periodicity \Rightarrow FFT computation
 $N^2 \rightarrow N \log_2 N$

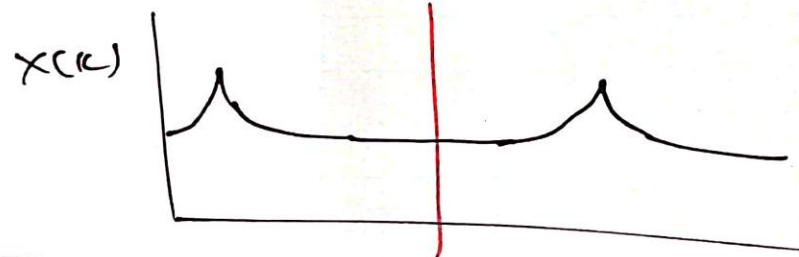
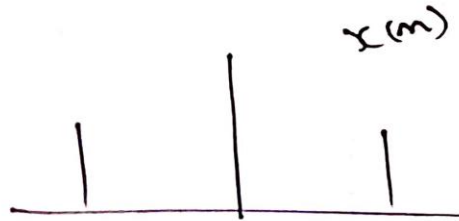
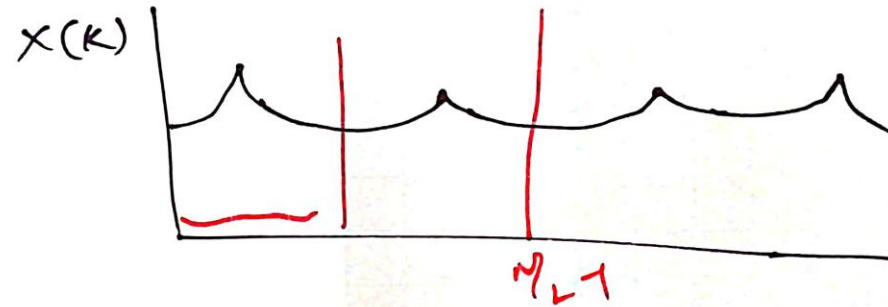
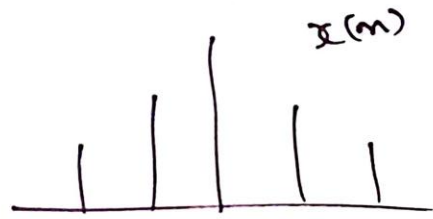
② Stretching in time domain (insertion of zeros)
 \Rightarrow Replication in frequency domain



Important Properties of DFT

③ Decimation \Rightarrow Aliasing in frequency domain

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④ Appending zeros in time domain \Rightarrow Interpolation in frequency domain

