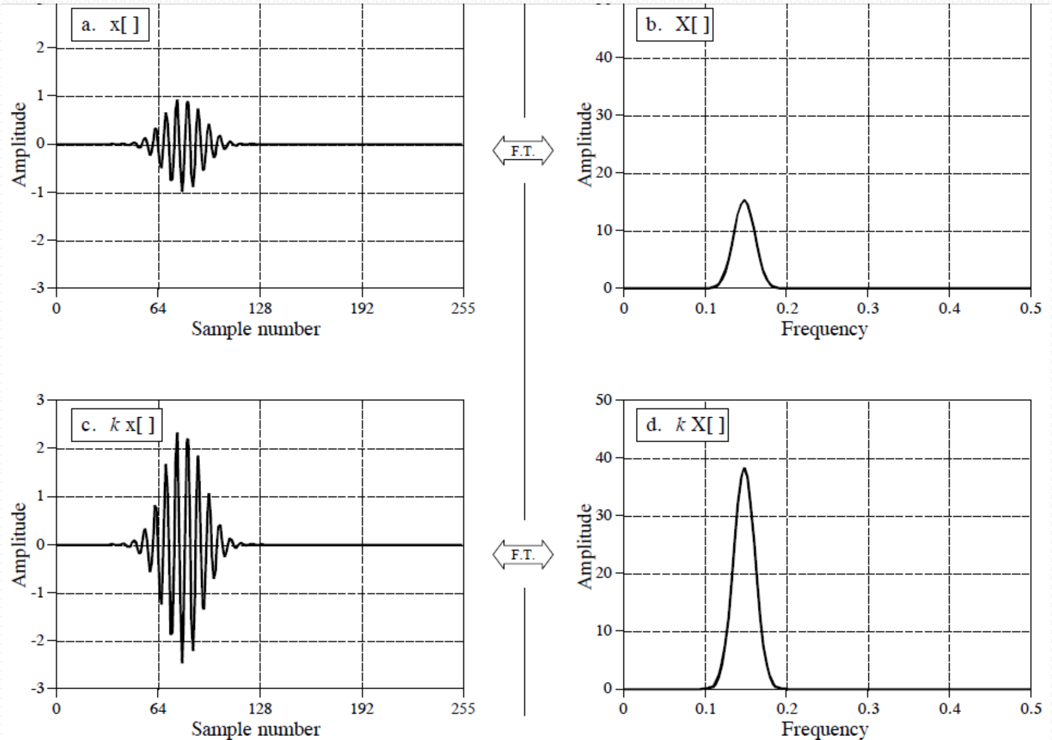
EE327 Digital Signal Processing DFT Pairs

Yasser F. O. Mohammad

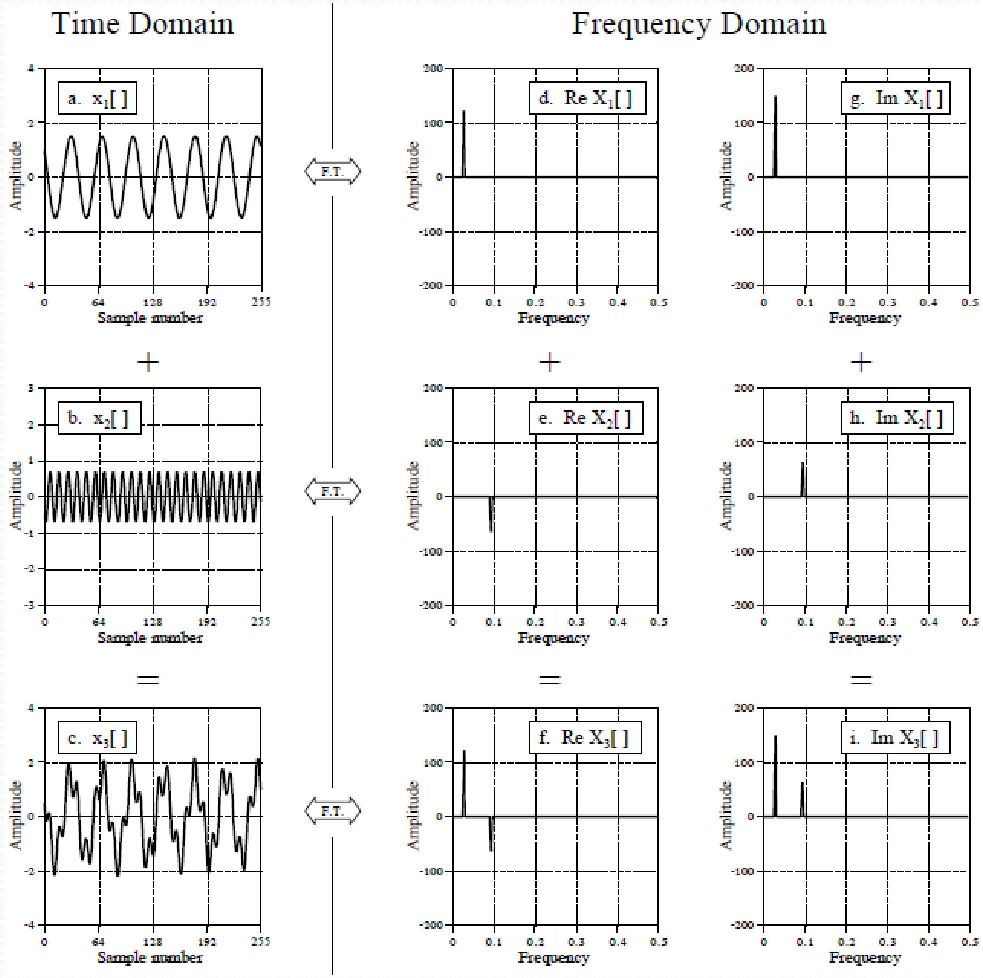
REMINER 1: Fourier Transform is Additive

- Scaling of the amplitude in one domain produces a scaling with the SAME factor in the amplitude of the other domain.
- *Use polar or rectangular coordinates*



REMINDER 2: Fourier Transform is Homogeneous

- Addition in one domain results in addition in the other domain.
- *MUST Use rectangular coordinates*
- *NEVER add magnitudes in the frequency domain*



REMINDER 3: Time Shift = Phase slope offset

$$x[n] \overset{DFT}{\underset{IDFT}{\longleftrightarrow}} MagX[f], PhaseX[f]$$

$$\Downarrow$$

$$x[n+s] \overset{DFT}{\underset{IDFT}{\longleftrightarrow}} MagX[f], PhaseX[f] + 2\pi sf$$

- Right Shift in time domain ←→Decrease in slope of the phase

Phase will be drawn unwrapped in this lecture

REMINDER 4: Time Flipping

- Flipping time domain negates the phase

$$x[n] \xleftrightarrow[IDFT]{DFT} \operatorname{Re} X[f], \operatorname{Im} X[f]$$

$$x[-n] \xleftrightarrow[IDFT]{DFT} \operatorname{Re} X[f], -\operatorname{Im} X[f]$$

REMINDER 5: DTFT

- Decomposition

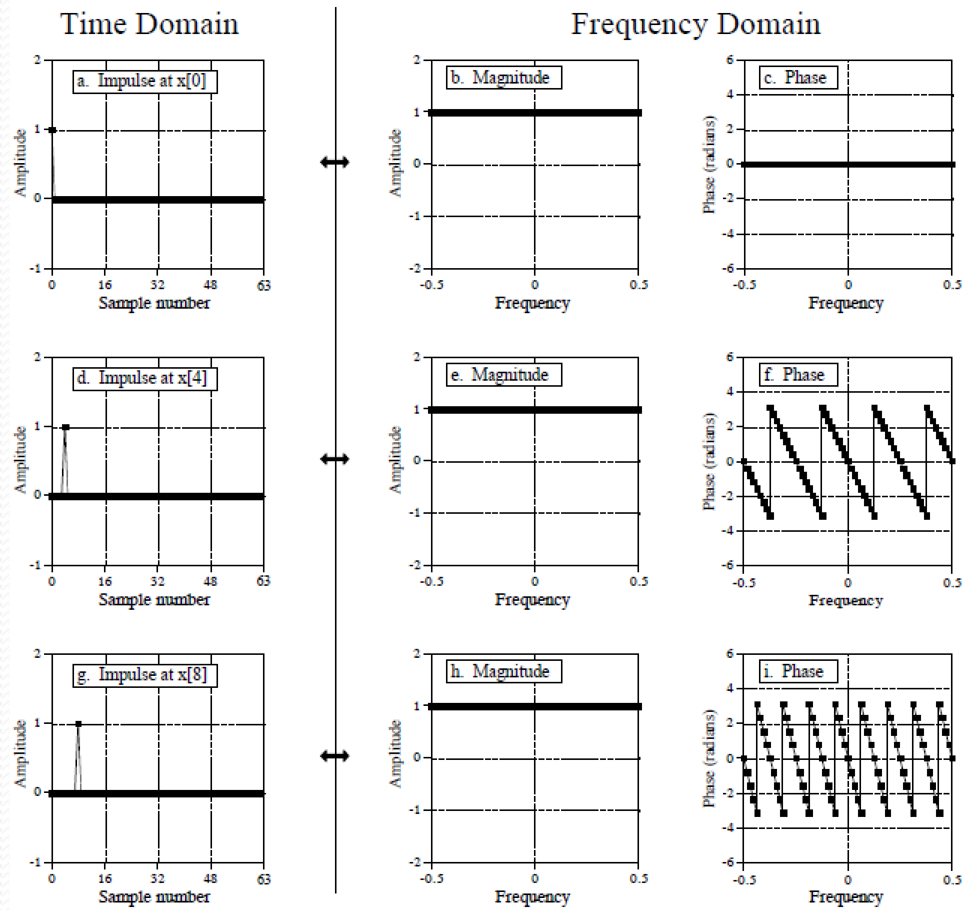
$$ReX(\omega) = \sum_{n=-\infty}^{+\infty} x[n]\cos(\omega n)$$

$$ImX(\omega) = -\sum_{n=-\infty}^{+\infty} x[n]\sin(\omega n)$$

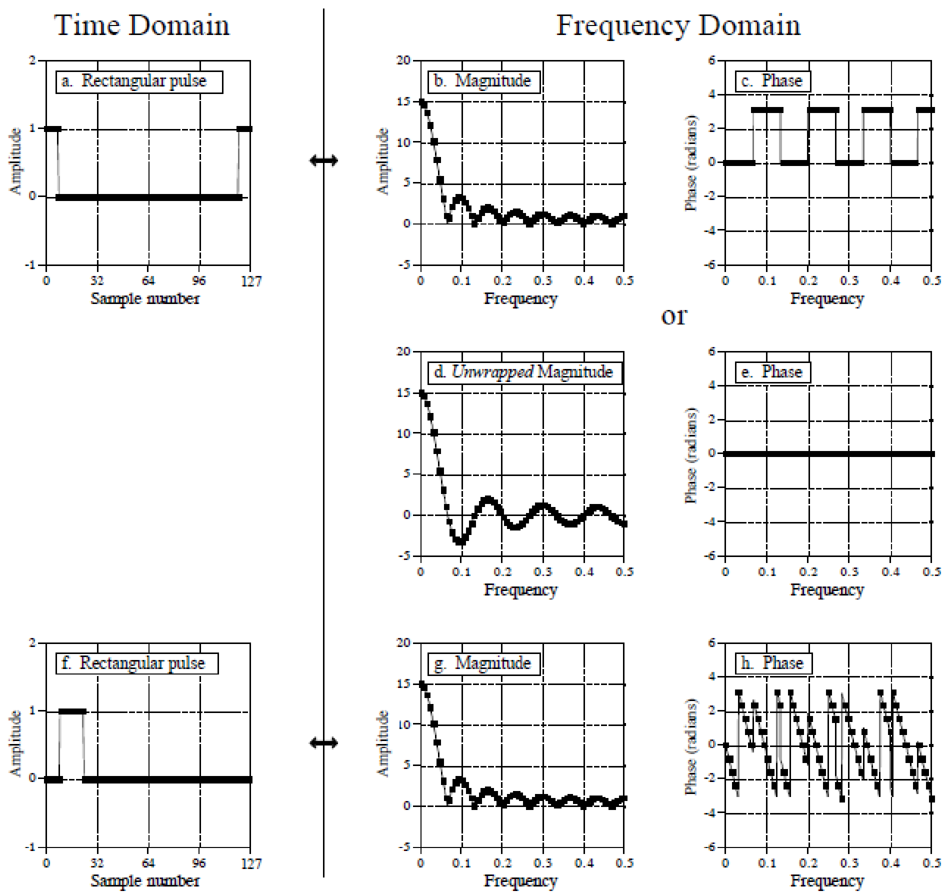
- Synthesis

$$x[n] = \frac{1}{\pi}\int_{0}^{\pi} ReX(\omega)\cos(\omega n) - ImX(\omega)\sin(\omega n)\,d\omega$$

Impulse ←→Constant Magnitude



Rectangular Pulse ←→Sinc



$$Mag\ X[k] = \left| \frac{\sin(\pi k M / N)}{\sin(\pi k / N)} \right|$$

Sinc ←→Rectangular Pulse

- Rectangular pulse in frequency domain

$$x[i] = \frac{1}{N} \frac{\sin(2\pi i (M - 1/2)/N)}{\sin(\pi i / N)}$$

REST of Chapter

- SELF READ