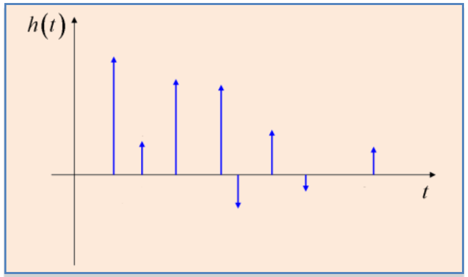
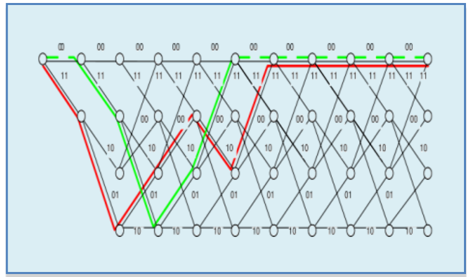
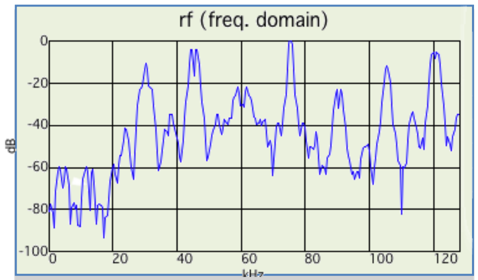
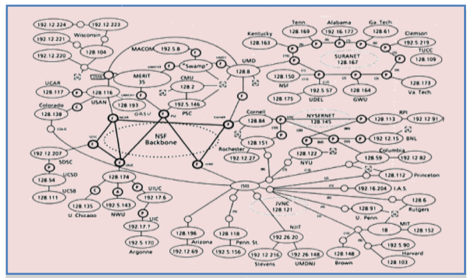








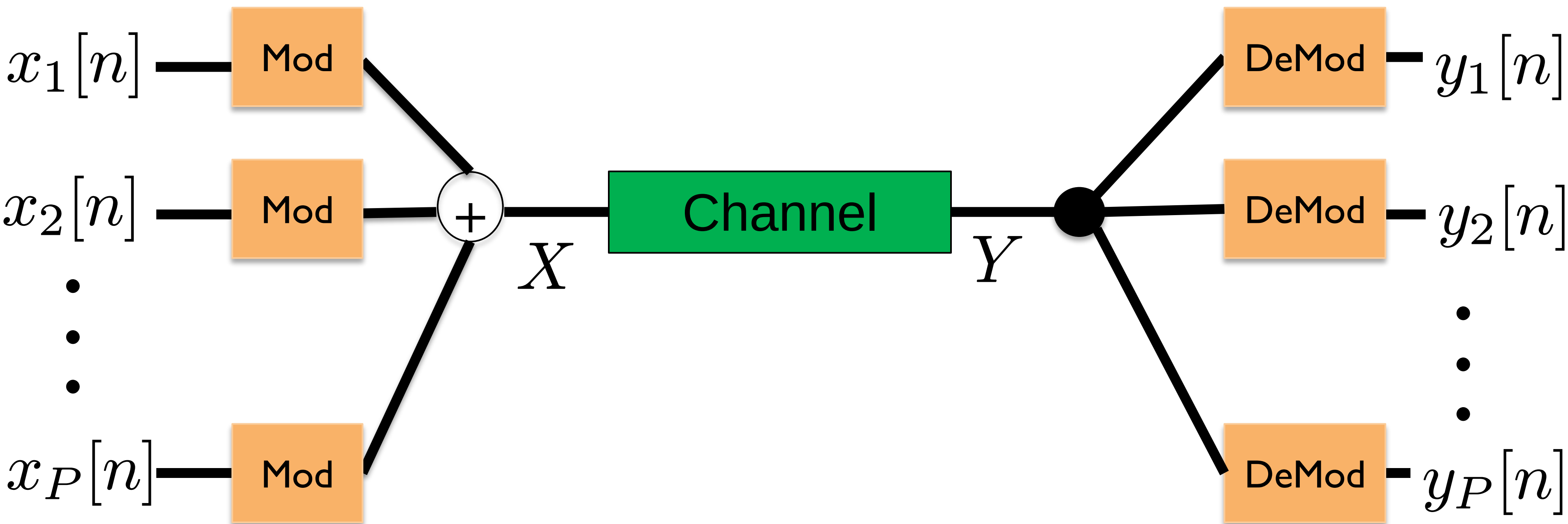
INTRODUCTION TO EECS II

DIGITAL COMMUNICATION SYSTEMS

6.02 Fall 2010
Lecture #14

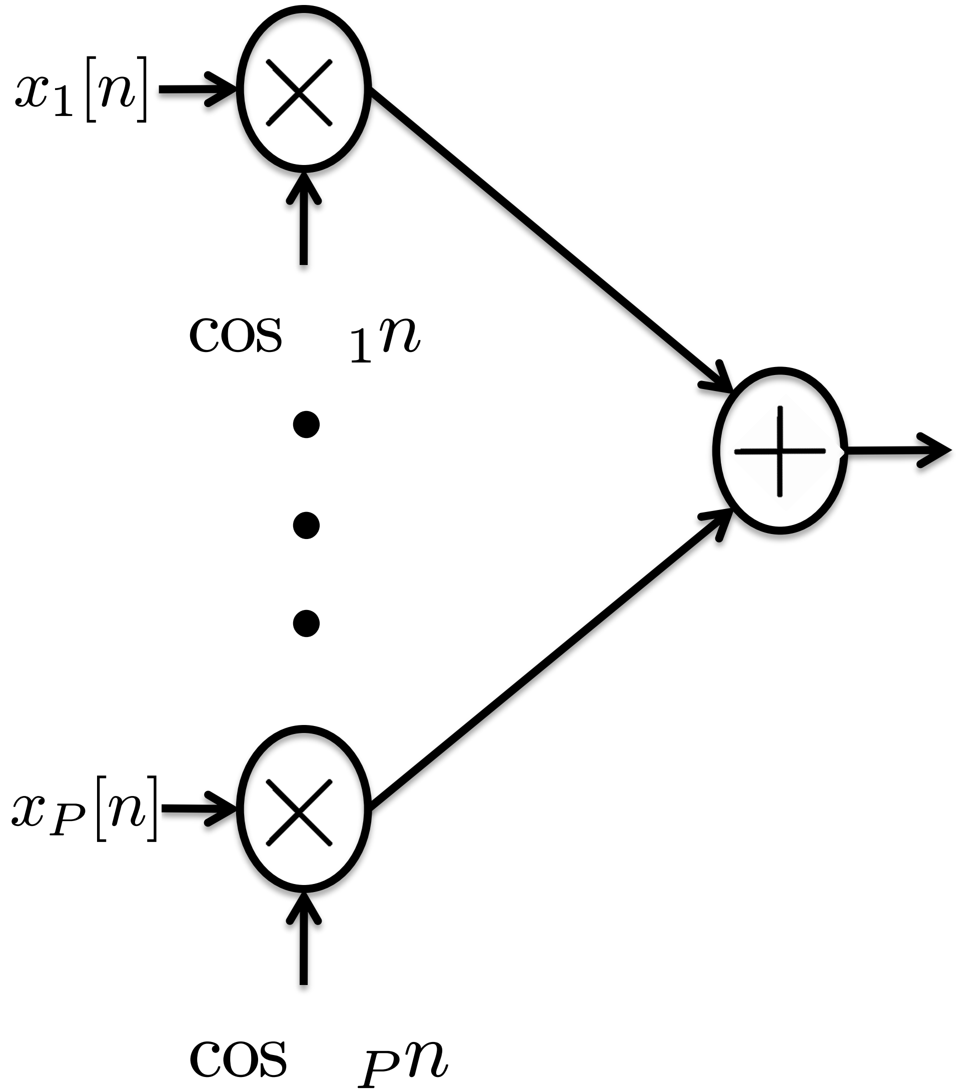
- Frequency Domain Sharing
- Spectrum and the Fourier Series
- Fourier Series Examples
- Rise Time and Spectrum

Frequency Domain Sharing - Big Picture



- Questions
  - What is Modulation (Mod in figure)?
  - What do typical X's look like?
  - What should the Demodulator be?
  - What is the relation between $x_i[n]$ and $y_i[n]$

Cosine Modulation

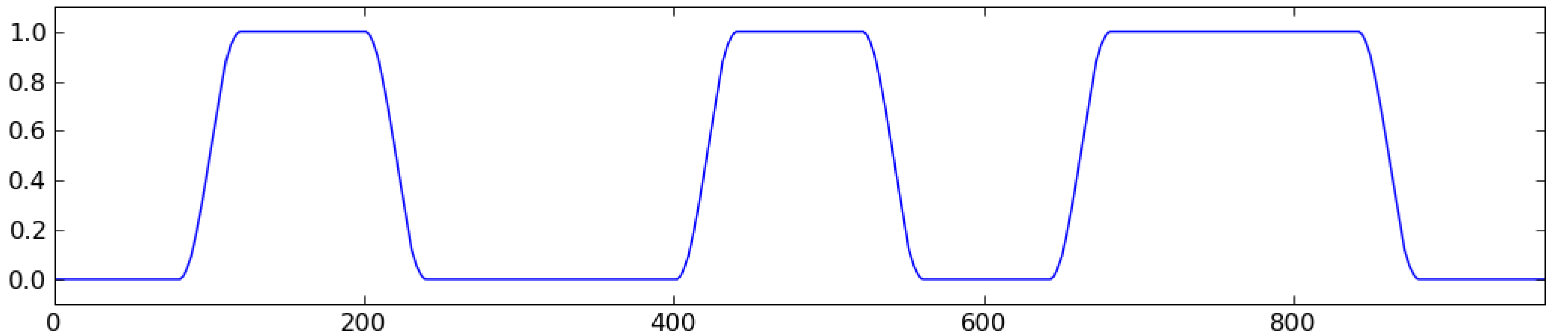


$$x[n] = \sum_{i=1}^{P} x_i[n] \cos \quad {}_i n$$

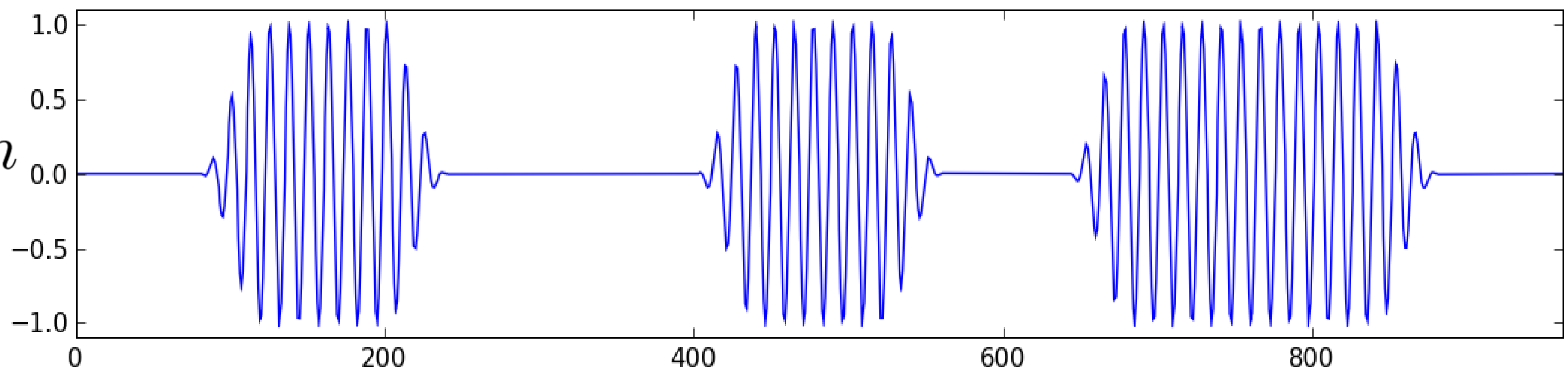
Ideal Channel Case $Y = X$

$$y[n] = \sum_{i=1}^{P} x_i[n] \cos \Omega_i n$$

$x_i[n]$

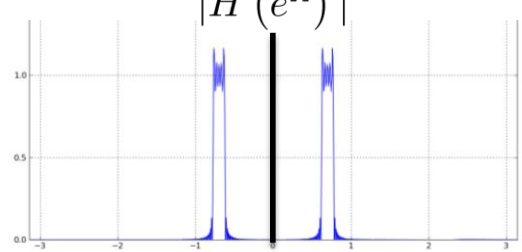


$x_i[n] \cos 0.5n$



$y[n] = \sum_{i=1}^{P} x_i[n] \cos \Omega_i n$

$|H\left(e^{\Omega}\right)|$

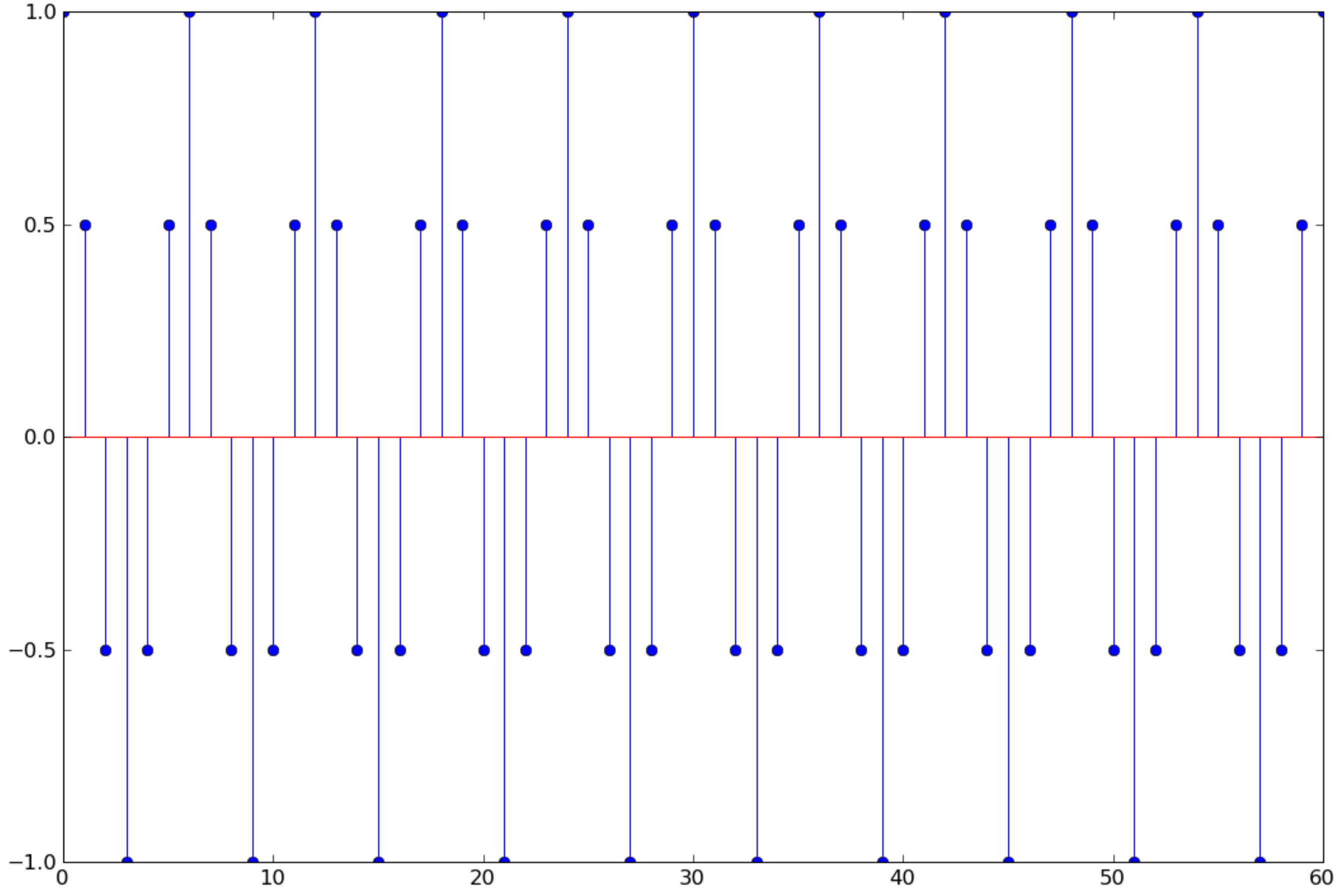


$-\Omega_k \quad \Omega_k$

?

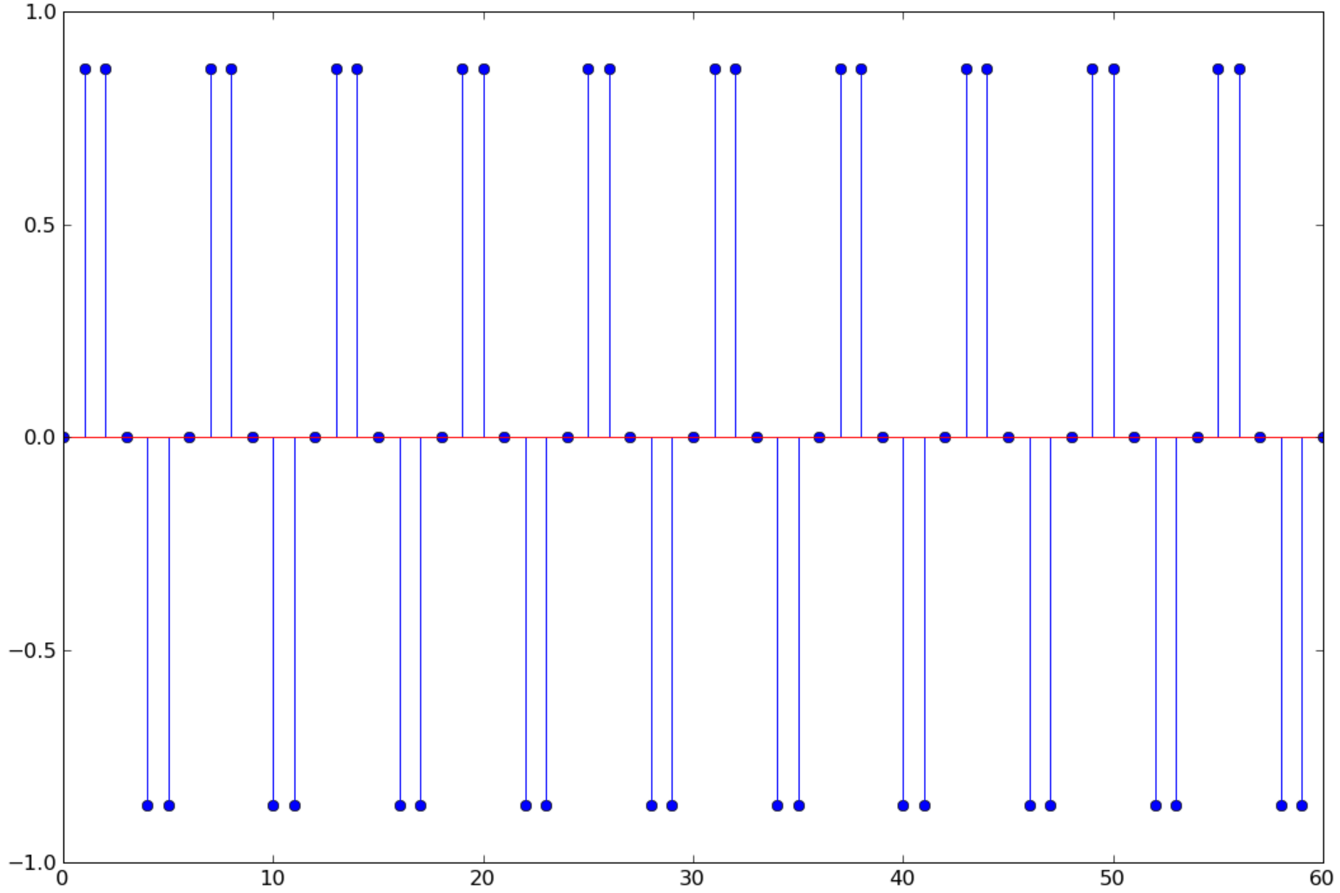
Cosine in Time

$$x[n] = \cos\frac{\pi}{3}n = \frac{1}{2}e^{j\frac{\pi}{3}n} + \frac{1}{2}e^{-j\frac{\pi}{3}n}$$



Sine in Time

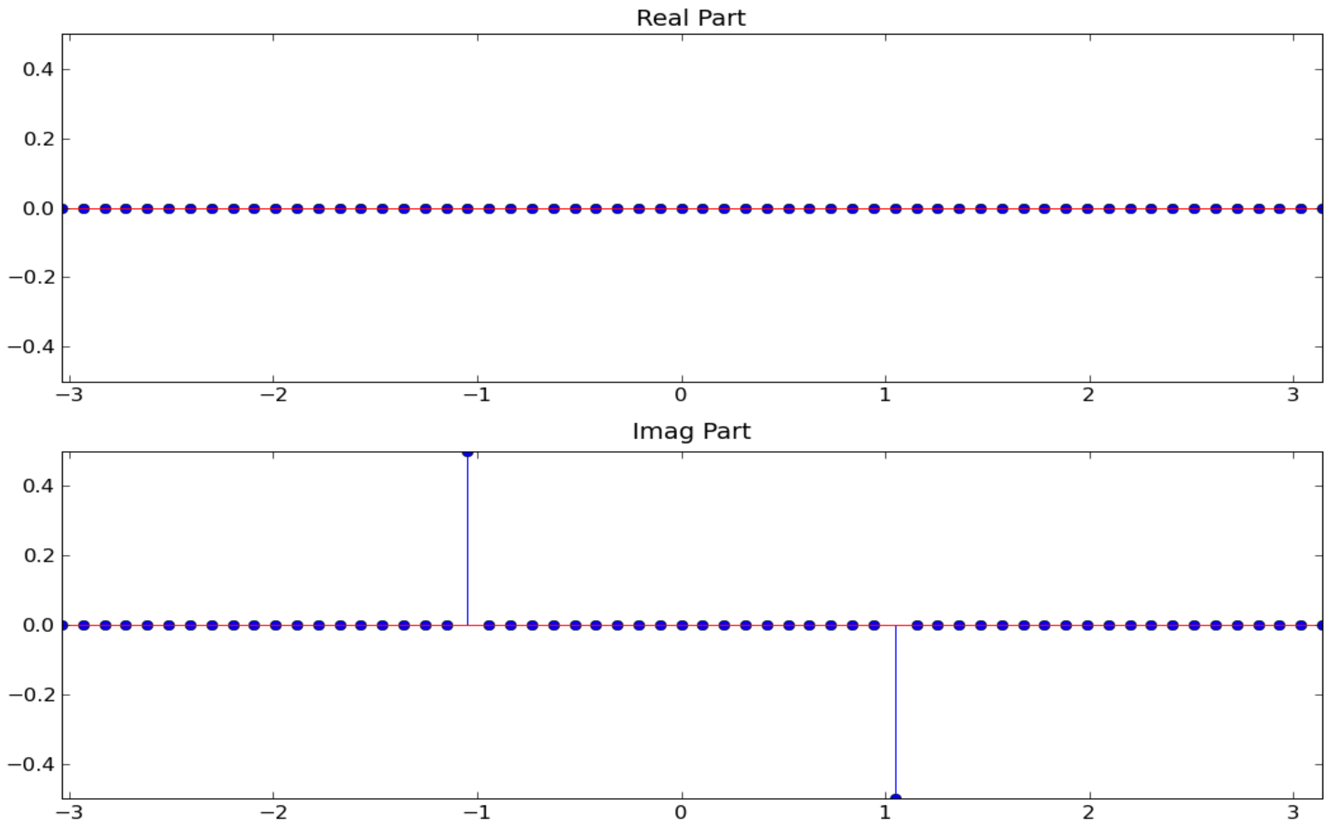
$$x[n] = \sin \tfrac{\pi}{3} n = \frac{-j}{2} e^{j\,\frac{\pi}{3} n} + \frac{j}{2} e^{-j\,\frac{\pi}{3} n}$$



Sine Fourier Series, 2 Imaginary values

$$x[n] = \sum_{k=-\frac{N}{2}}^{\frac{N}{2}-1} X[k] e^{j\frac{2\pi}{N}kn} = \frac{-j}{2} e^{j\frac{\pi}{3}n} + \frac{j}{2} e^{-j\frac{\pi}{3}n}$$

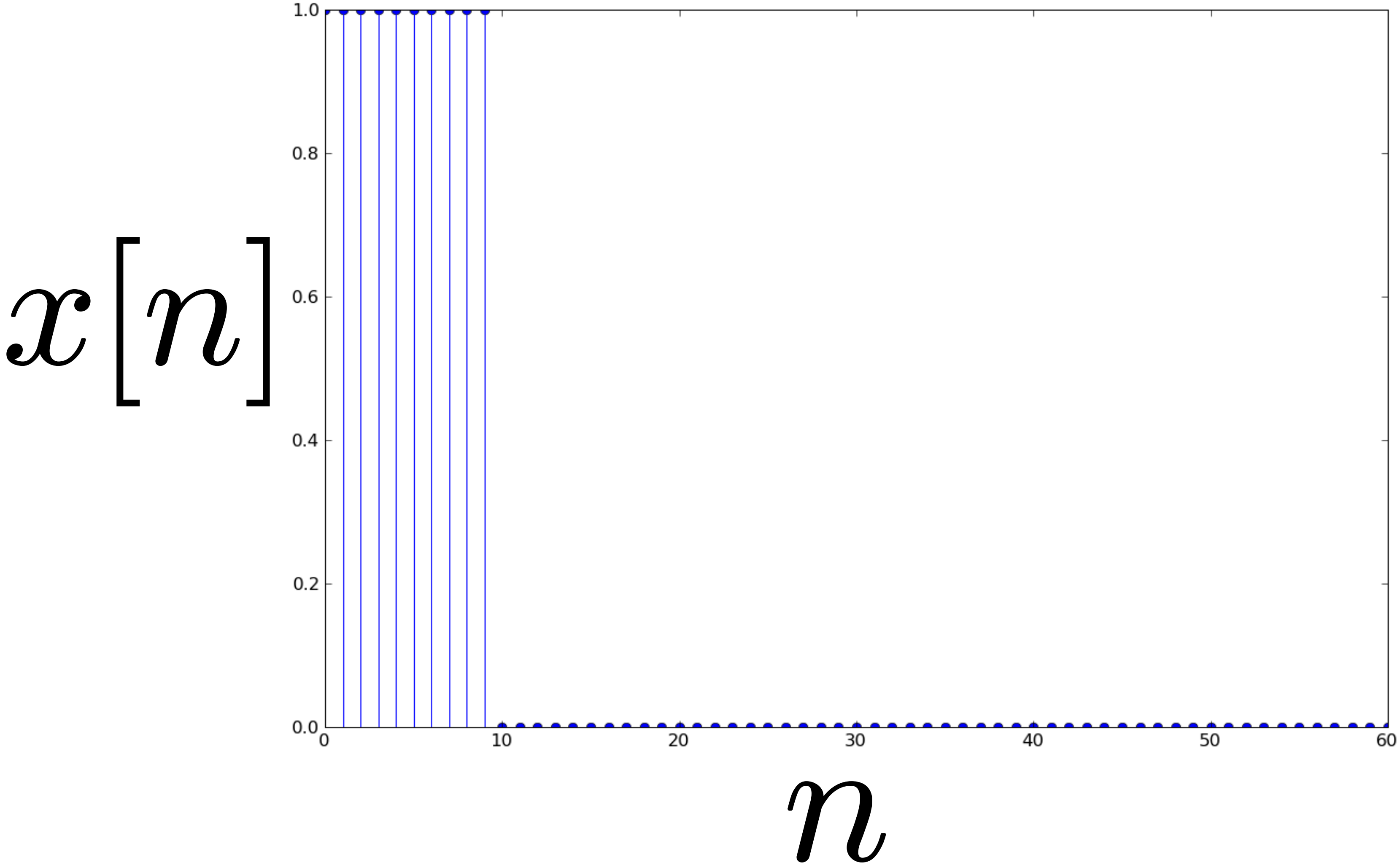
$X[k]$



$\frac{2\pi}{N}k$

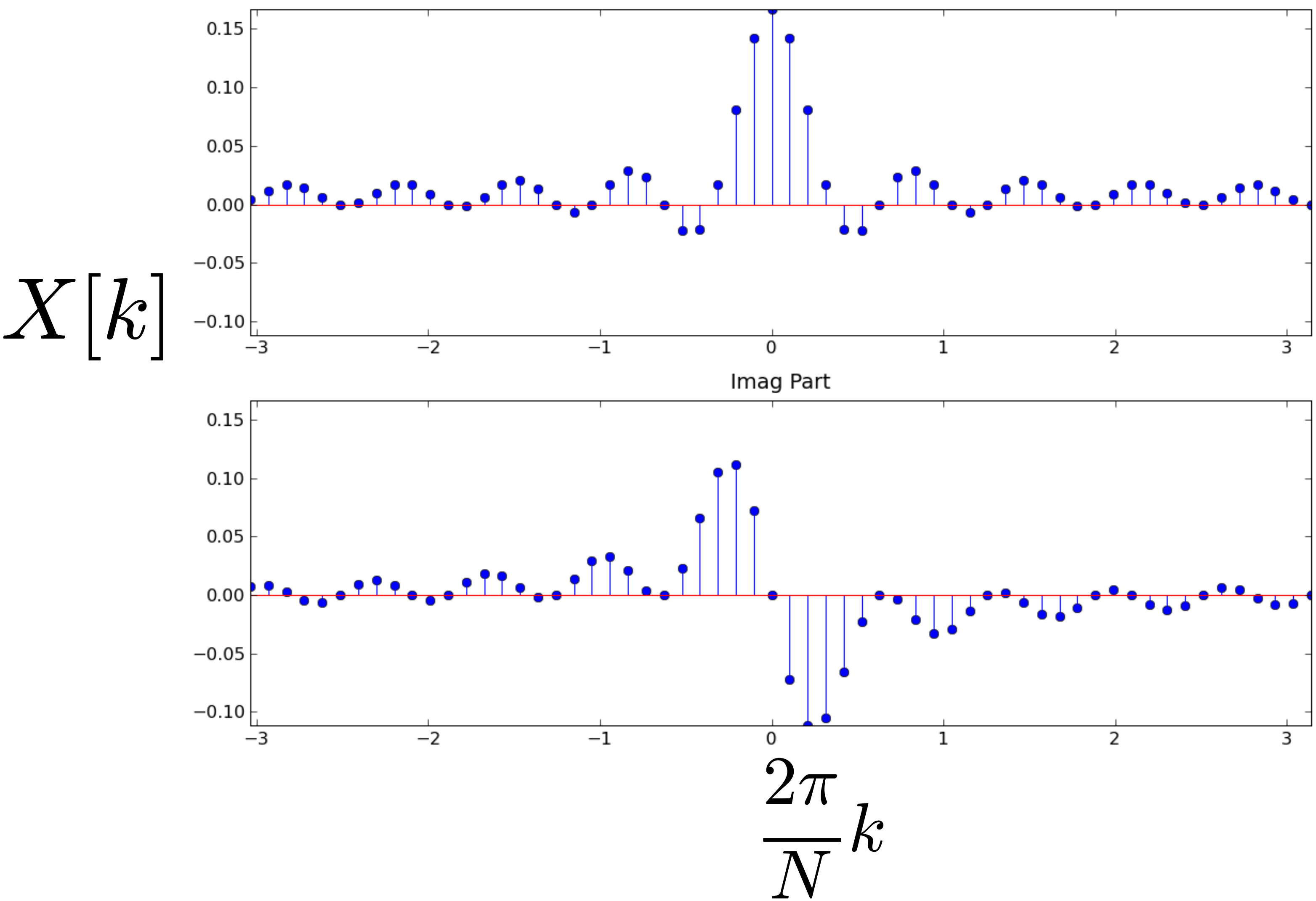
Note horizontal axis ranges over –pi to pi!

Fast Rise Pulse

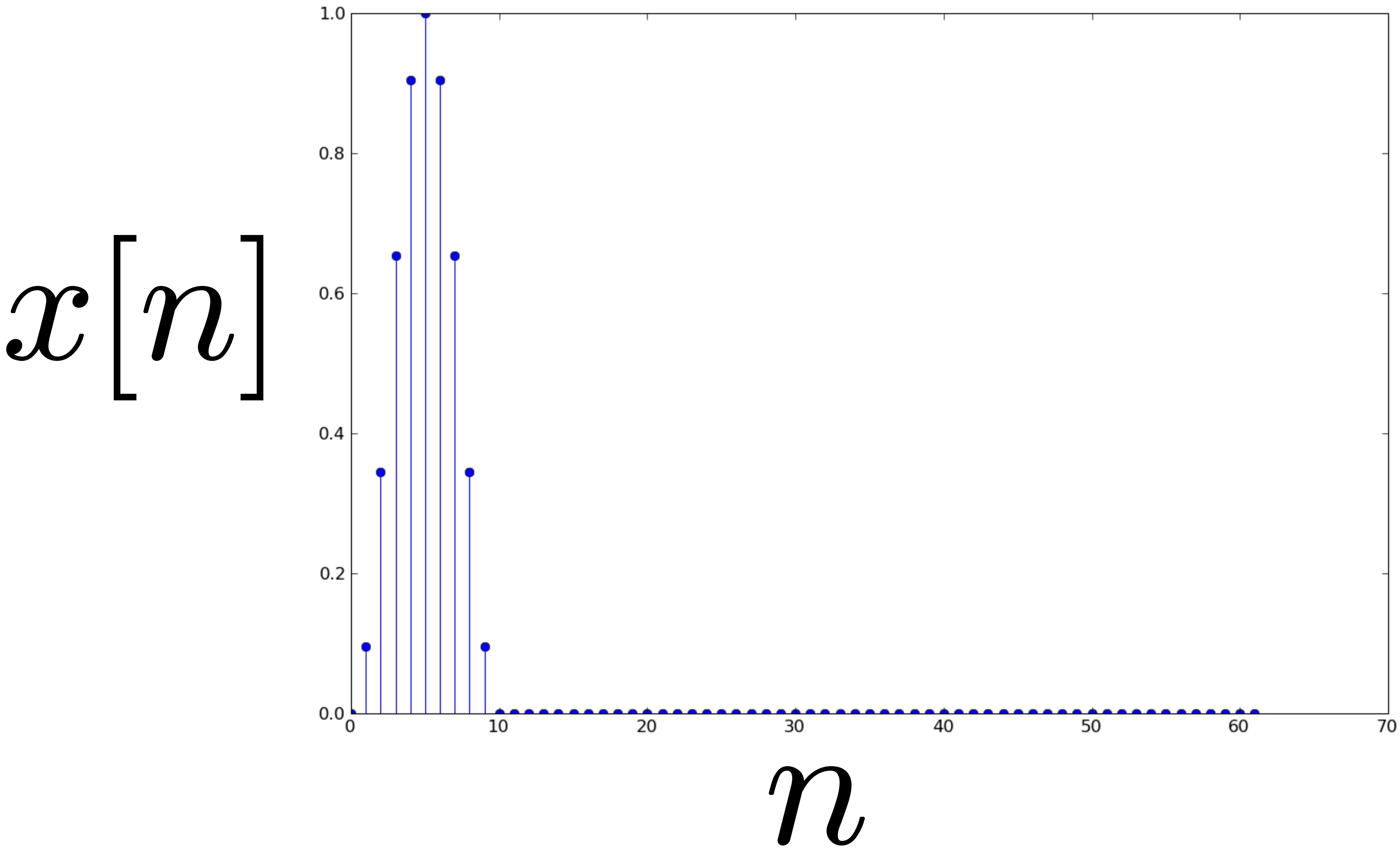


Spectrum of Fast Rise Pulse

$$x[n] = \sum_{k=-\frac{N}{2}}^{\frac{N}{2}-1} X[k] e^{j\frac{2\pi}{N}kn}$$



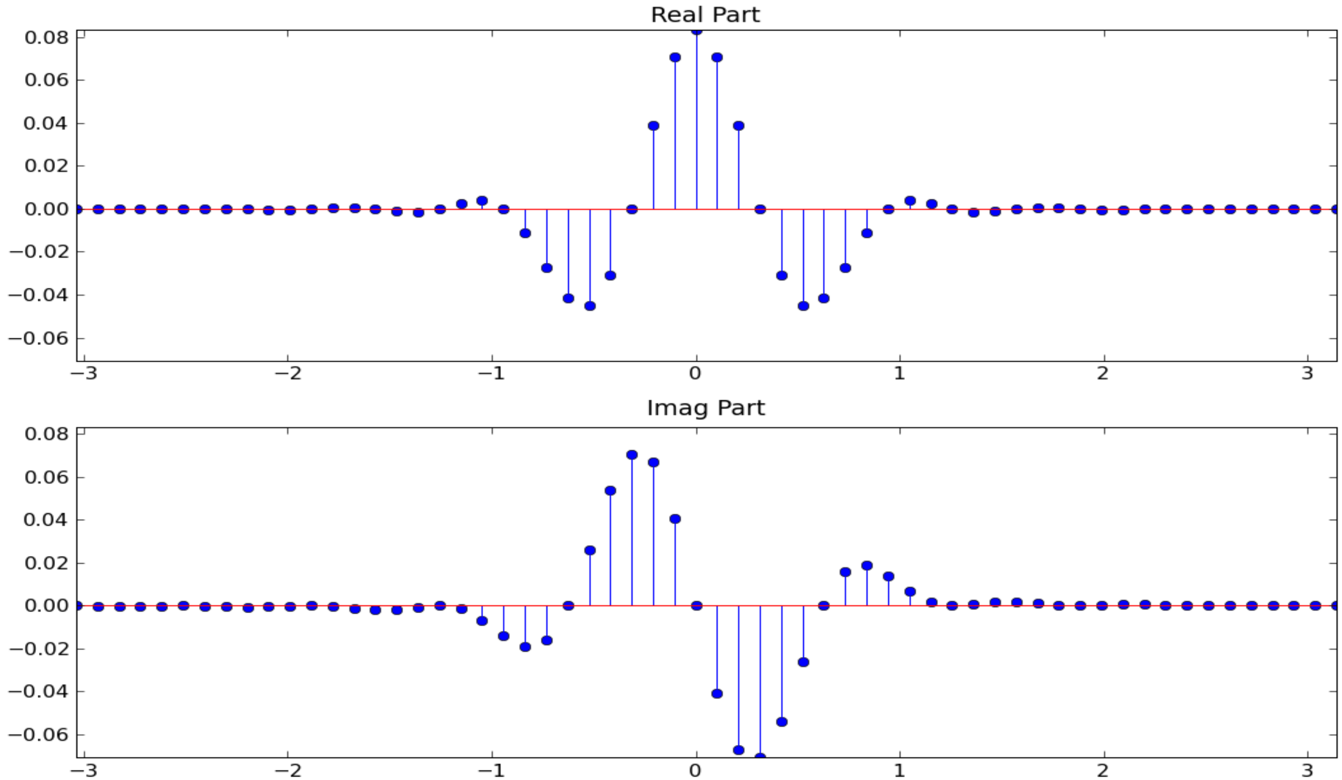
Slow Rise Pulse



Spectrum Slow Rise Pulse

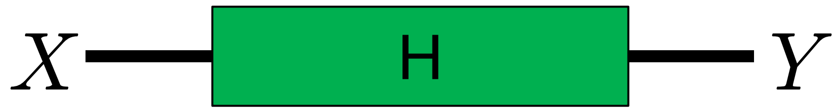
$$x[n] = \sum_{k=-\frac{N}{2}}^{\frac{N}{2}-1} X[k] e^{j\frac{2\pi}{N}kn}$$

$X[k]$



$$\frac{2\pi}{N}k$$

Key Fourier Series Advantage



$$y[n] = \sum_{m=0}^{n} h[m]x[n-m]$$

OR

$$x[n] = \sum_{k=-\frac{N}{2}}^{\frac{N}{2}-1} X[k]e^{j\frac{2\pi}{N}kn} \Rightarrow y[n] = \sum_{k=-\frac{N}{2}}^{\frac{N}{2}-1} H(e^{j\frac{2\pi}{N}k})X[k]e^{j\frac{2\pi}{N}kn}$$

$$H(e^{j\ \ }) = \sum_{m=0}^{L} h[m]e^{-j\ \ m}$$