





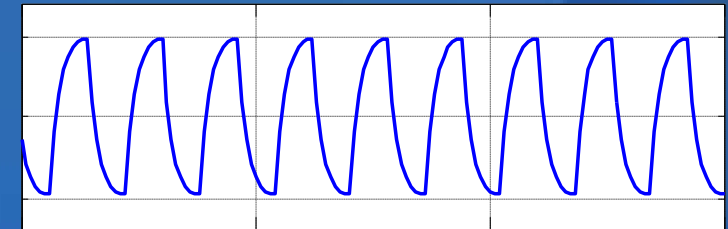
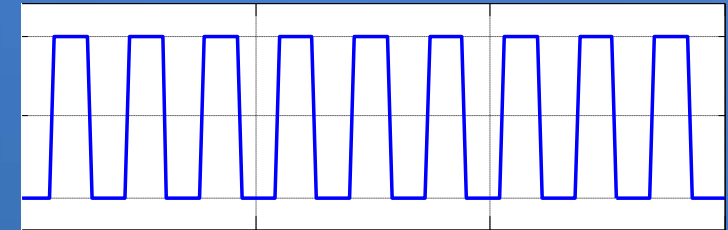
# Filters and the Frequency Domain

# Filtering



input =  +  +  +  + 

output = 100%  + 90%   
+ 10%  + 1% 



# Fourier Analysis

The Fourier Series expansion decomposes a signal into a sum of scaled and shifted cosines.

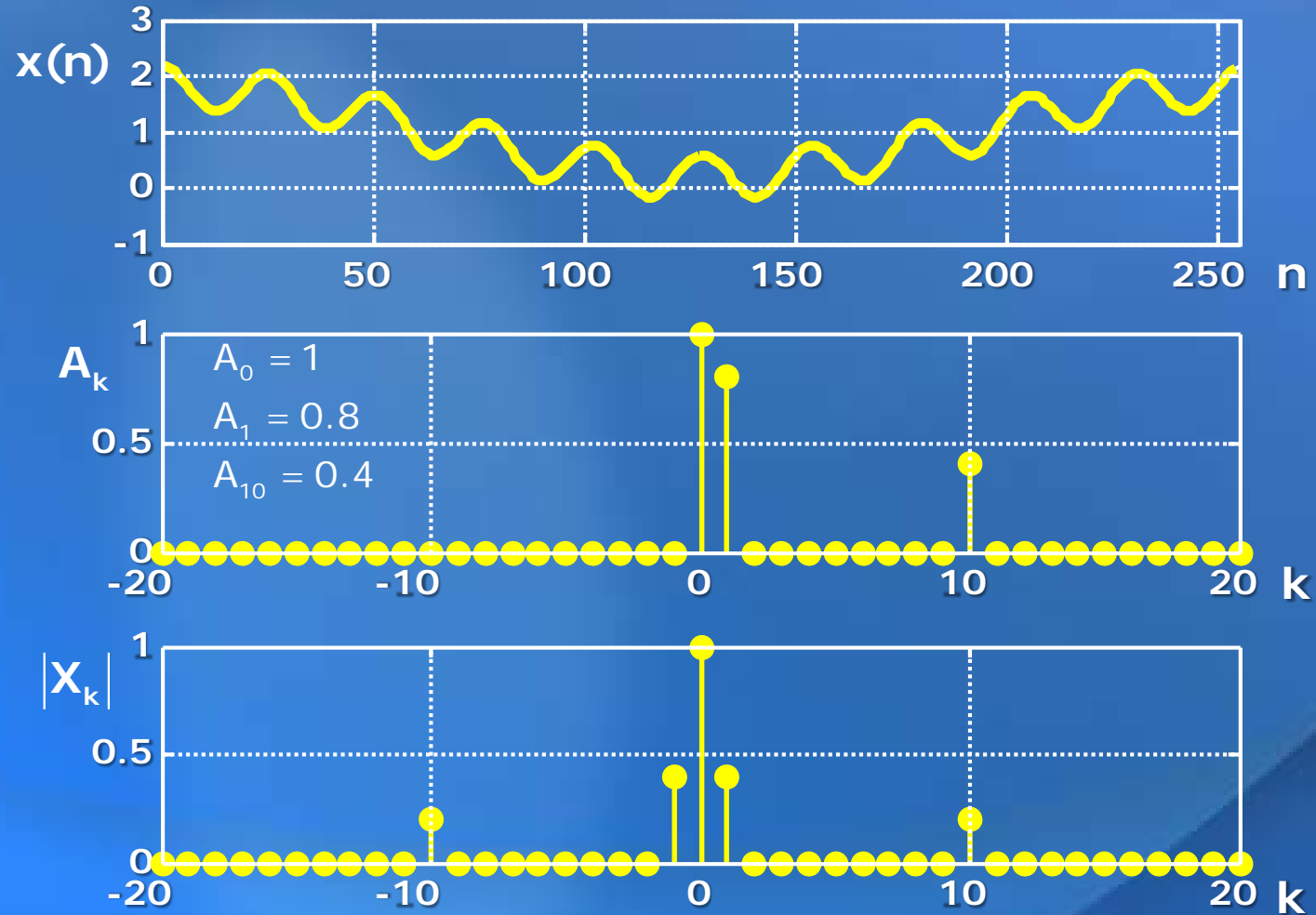
$$x(n) = \sum_{k=0}^{N/2} A_k \cos(2\pi f_k n + \phi_k) \quad f_k = \frac{k}{N}$$

The Fourier Transform decomposes a signal into a sum of scaled complex exponentials.

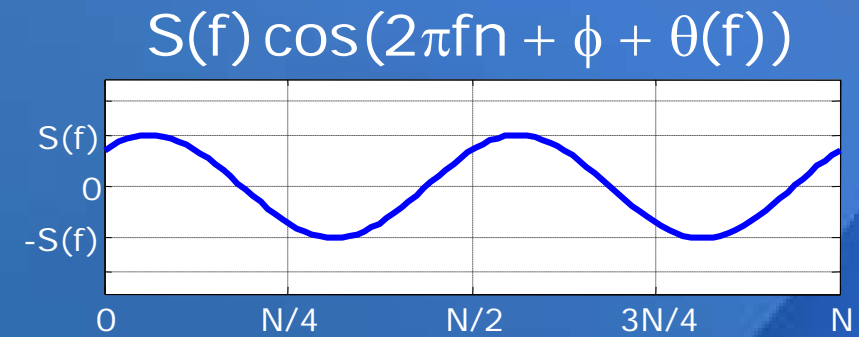
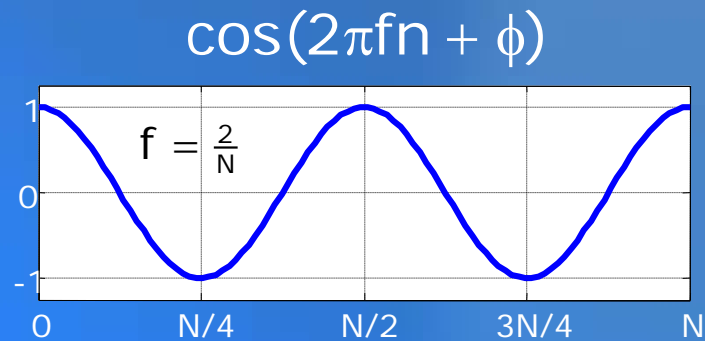
$$x(n) = \sum_{k=-N/2}^{N/2} X_k \cdot e^{j2\pi f_k n}$$

$$X_k = \begin{cases} \frac{A_k}{2} e^{-j\phi_k} & k < 0 \\ A_0 & k = 0 \\ \frac{A_k}{2} e^{j\phi_k} & k > 0 \end{cases}$$

# Amplitude Spectra







# Frequency Response



# Amplitude Responses

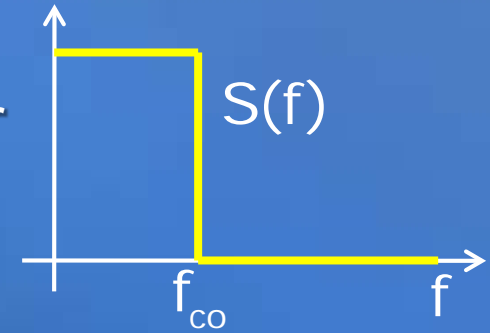


input =  +  +  +  + 

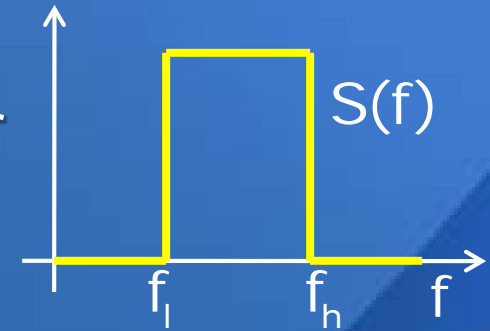
output = 100%  + 90%   
+ 10%  + 1% 

↑  
These percentages  
characterize the filter  
operation.

Lowpass Filter



Bandpass Filter



Highpass Filter

