

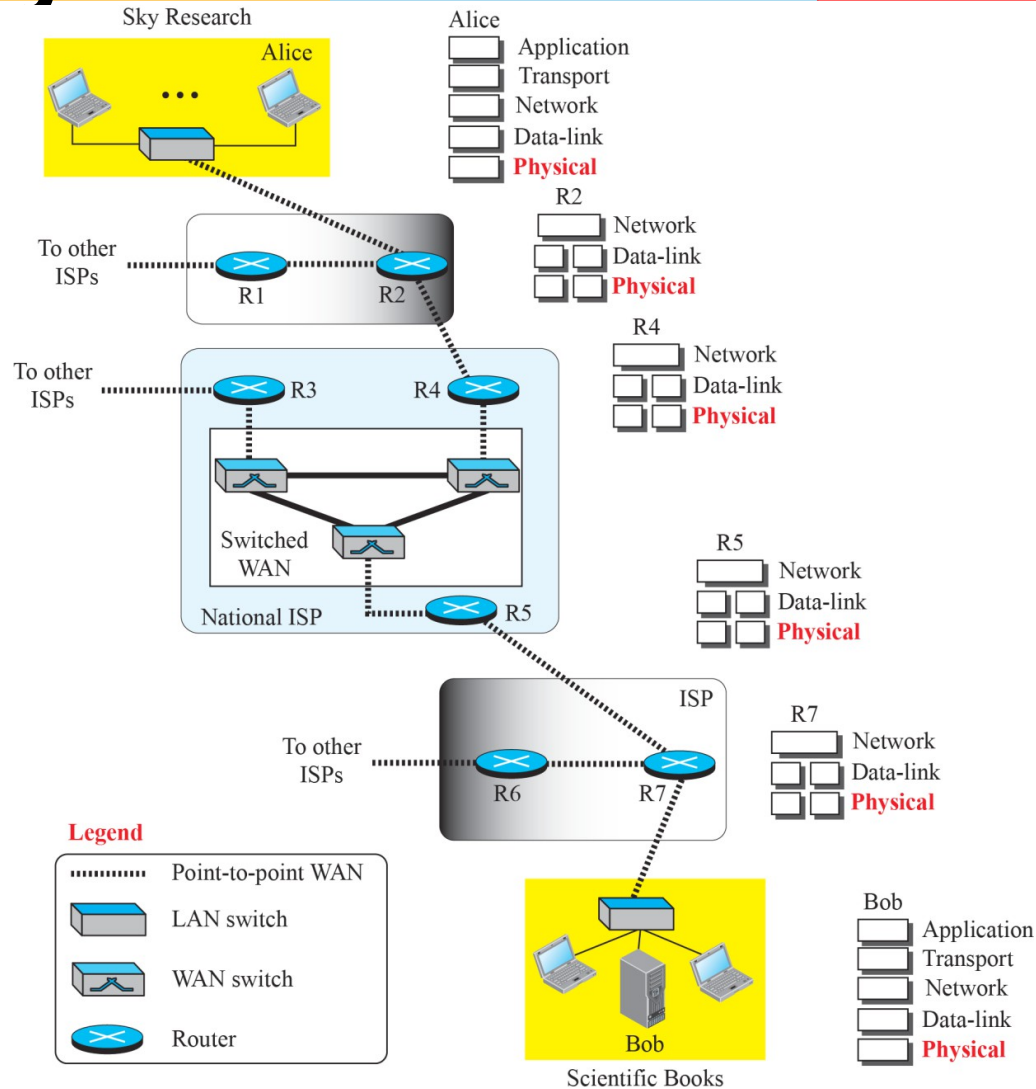


# Computer Networks: Physical layer

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Hyderabad Campus

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# Communication at Physical layer

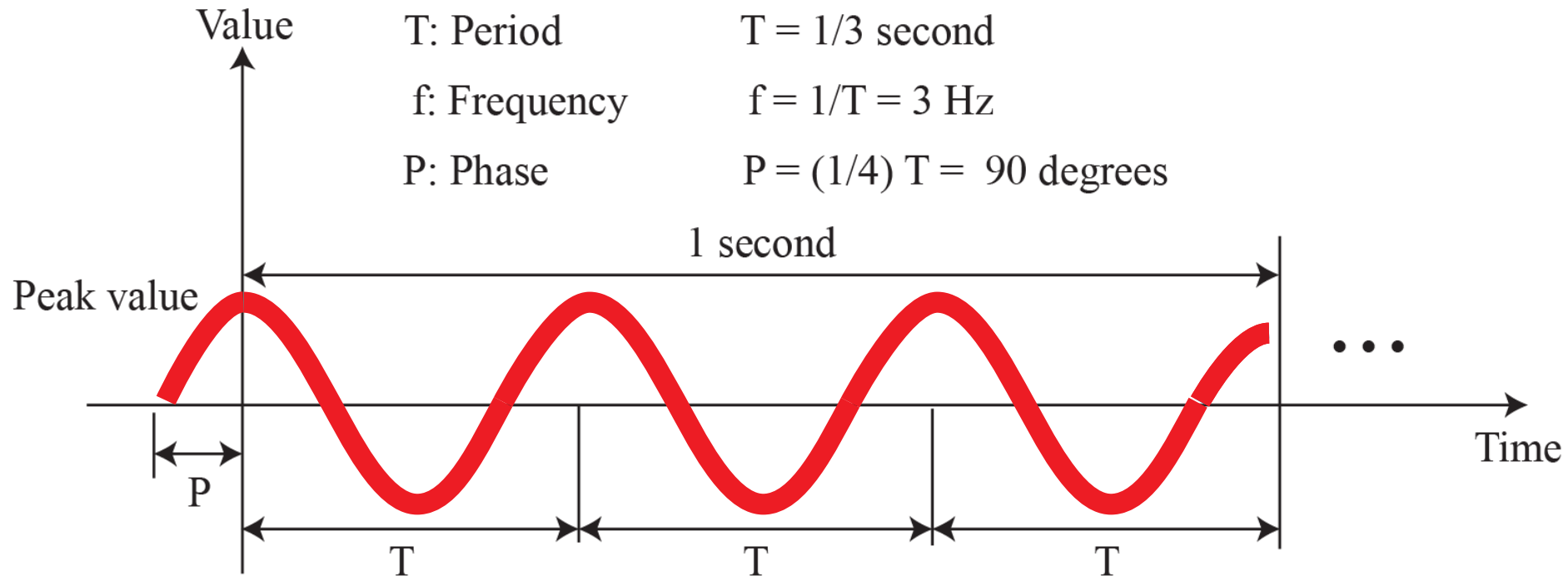


# Scope of Physical layer

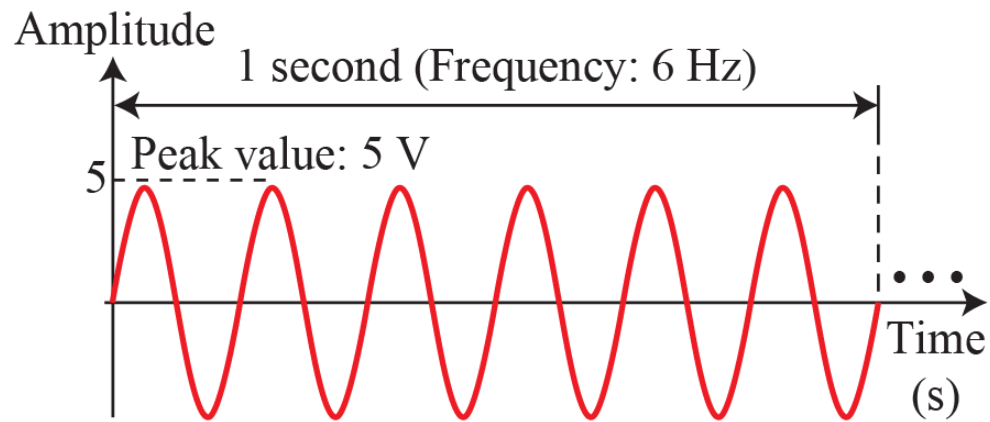
- Concerns how signals are used to transfer message bits over a link
  - Wires etc. carry analog signals
  - We want to send digital bits



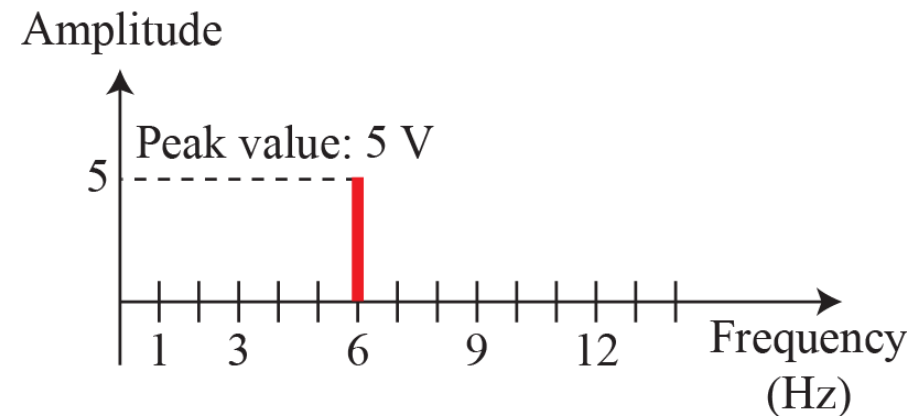
# Analog Signals



# Time and Frequency domains

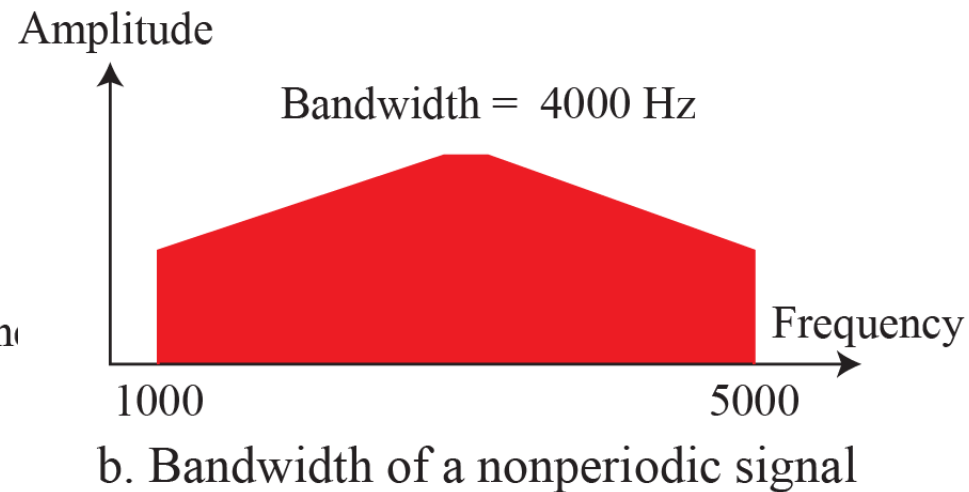
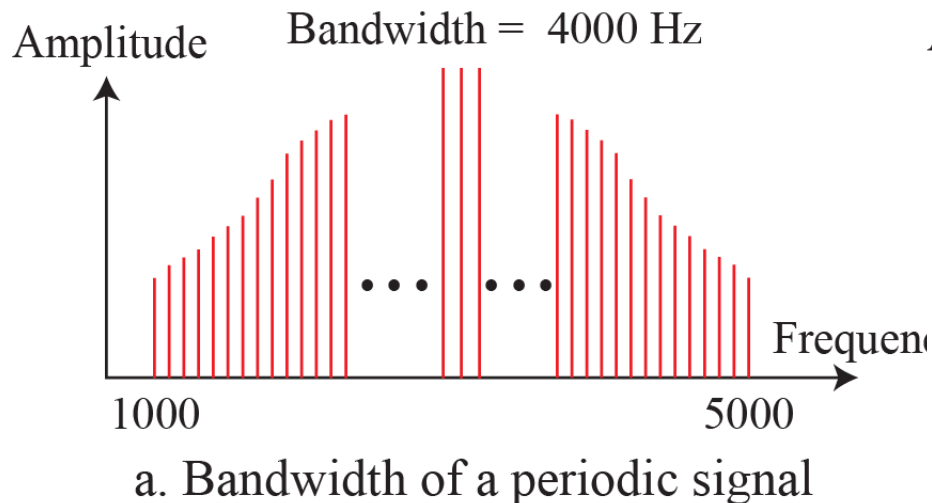
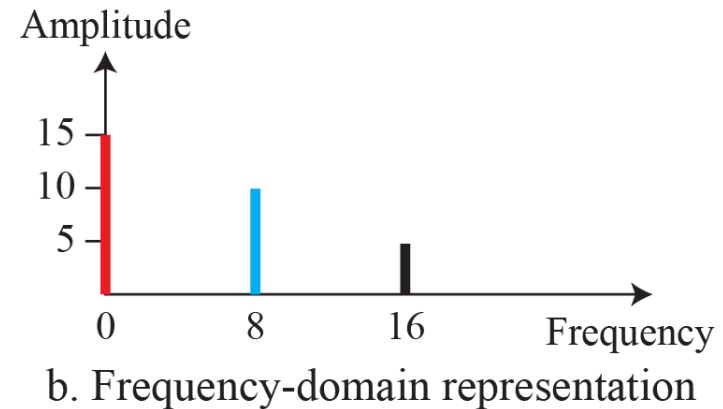
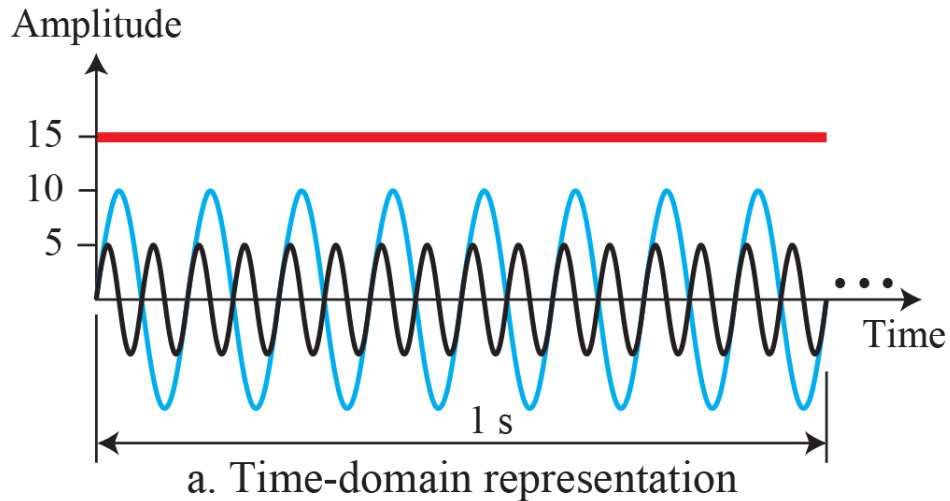


a. A sine wave in the time domain

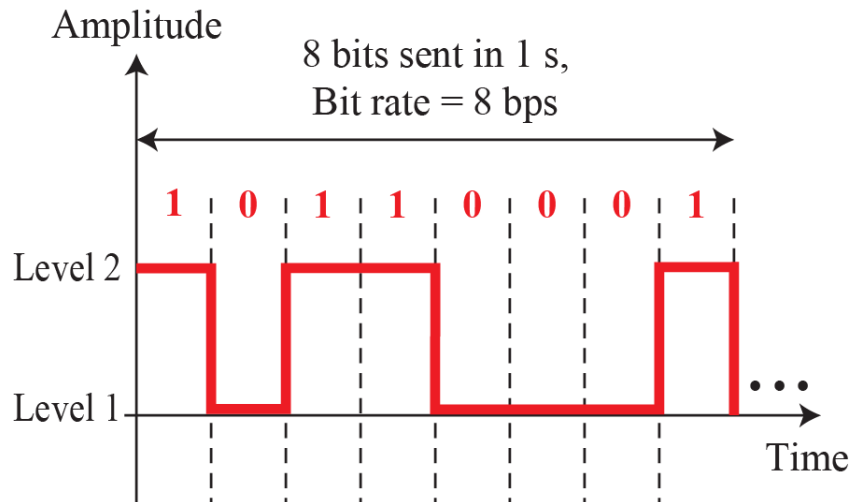


b. The same sine wave in the frequency domain

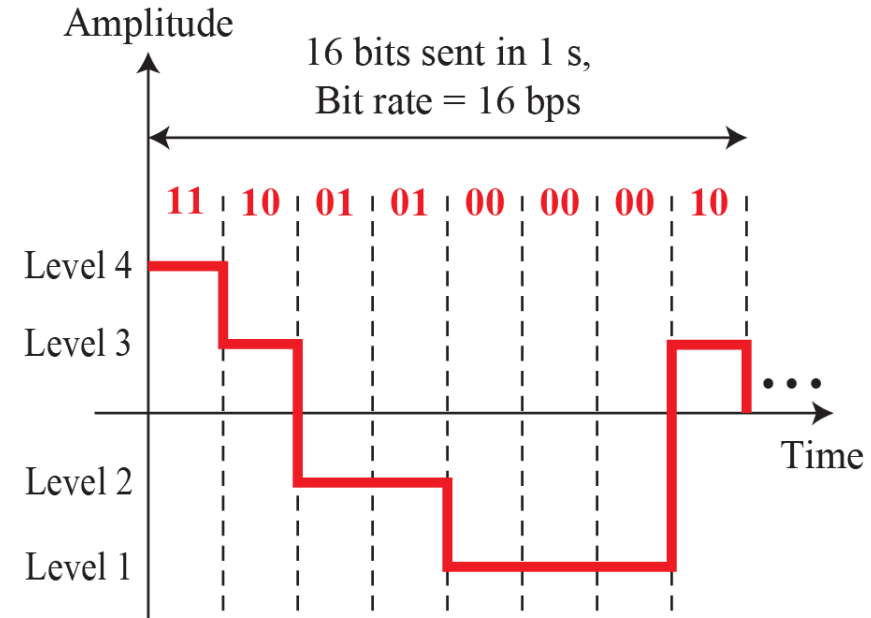
# Composite signals and bandwidth



# Digital signals and bit rate



a. A digital signal with two levels



b. A digital signal with four levels

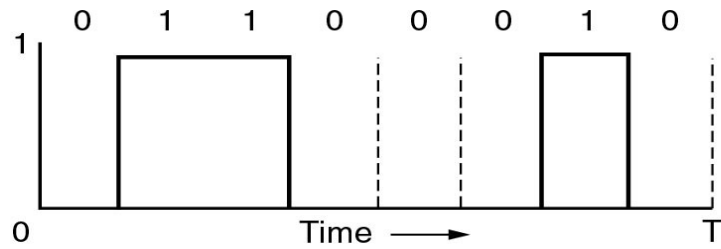
# Frequency representation



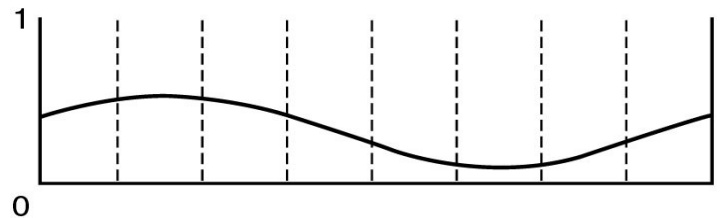
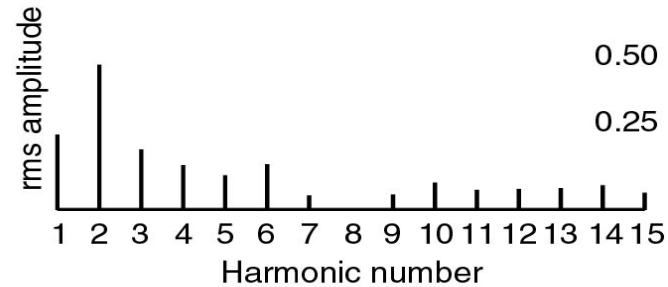
- A signal over time can be represented by its frequency components (called Fourier analysis)

$$g(t) = \frac{1}{2}c + \sum_{n=1}^{\infty} a_n \sin(2\pi nft) + \sum_{n=1}^{\infty} b_n \cos(2\pi nft)$$

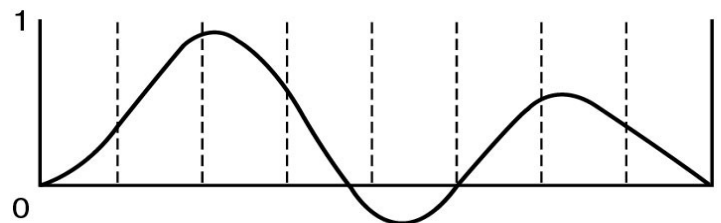
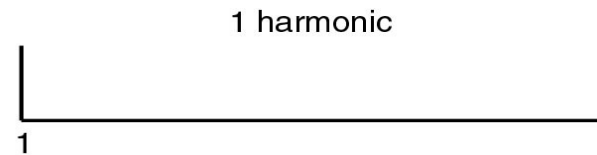
# Bandwidth limited signal



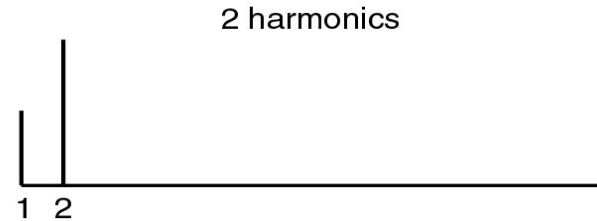
(a)



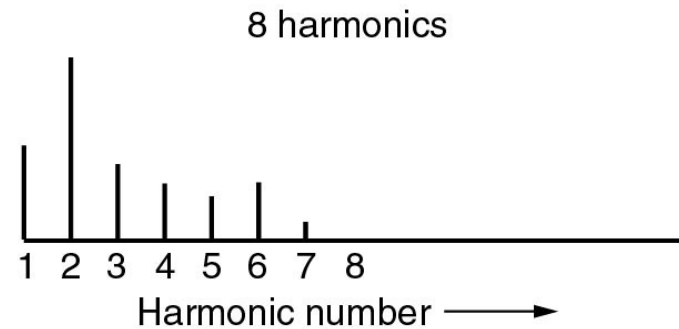
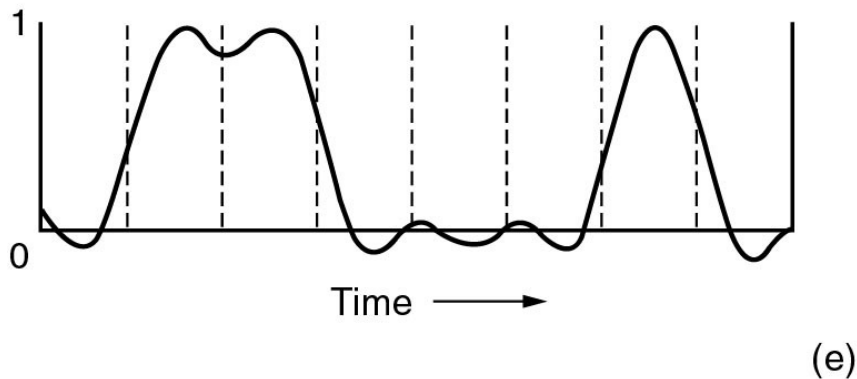
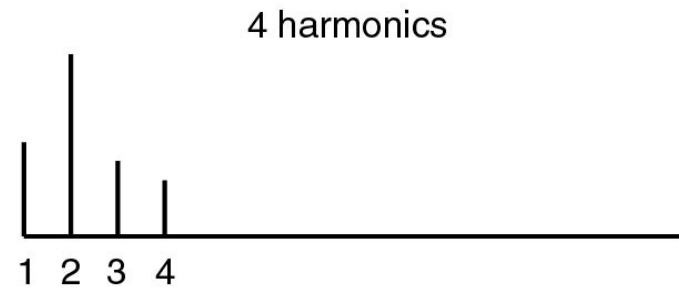
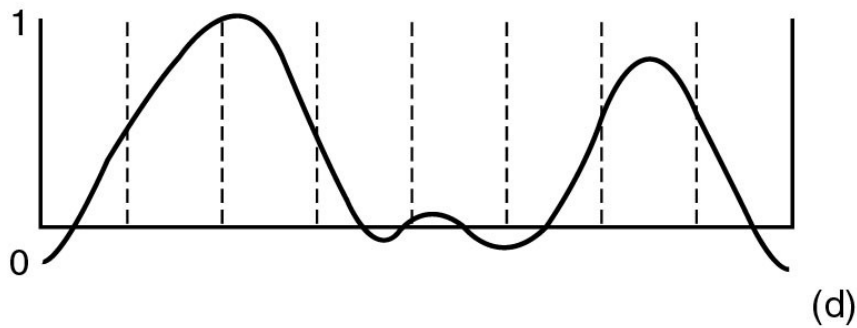
(b)



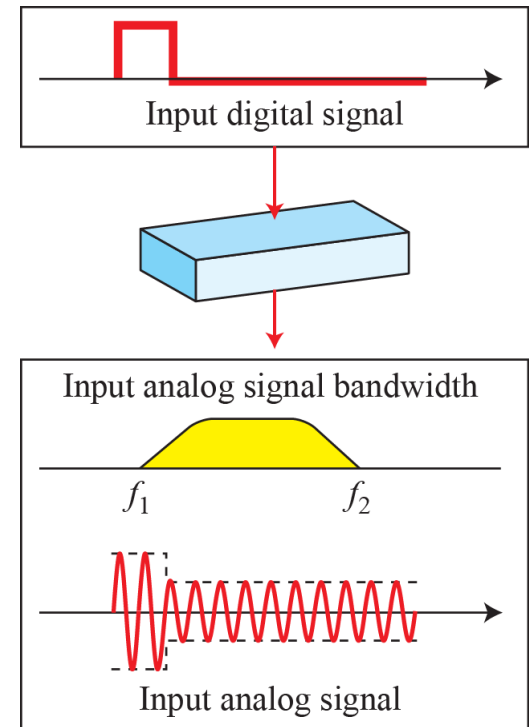
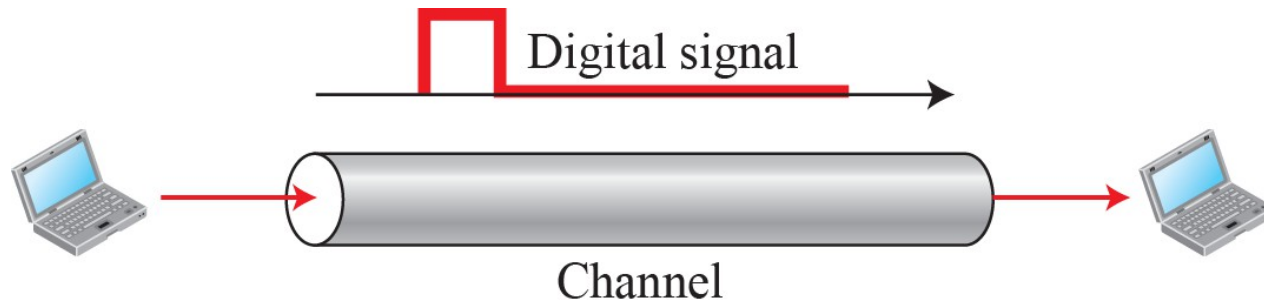
(c)



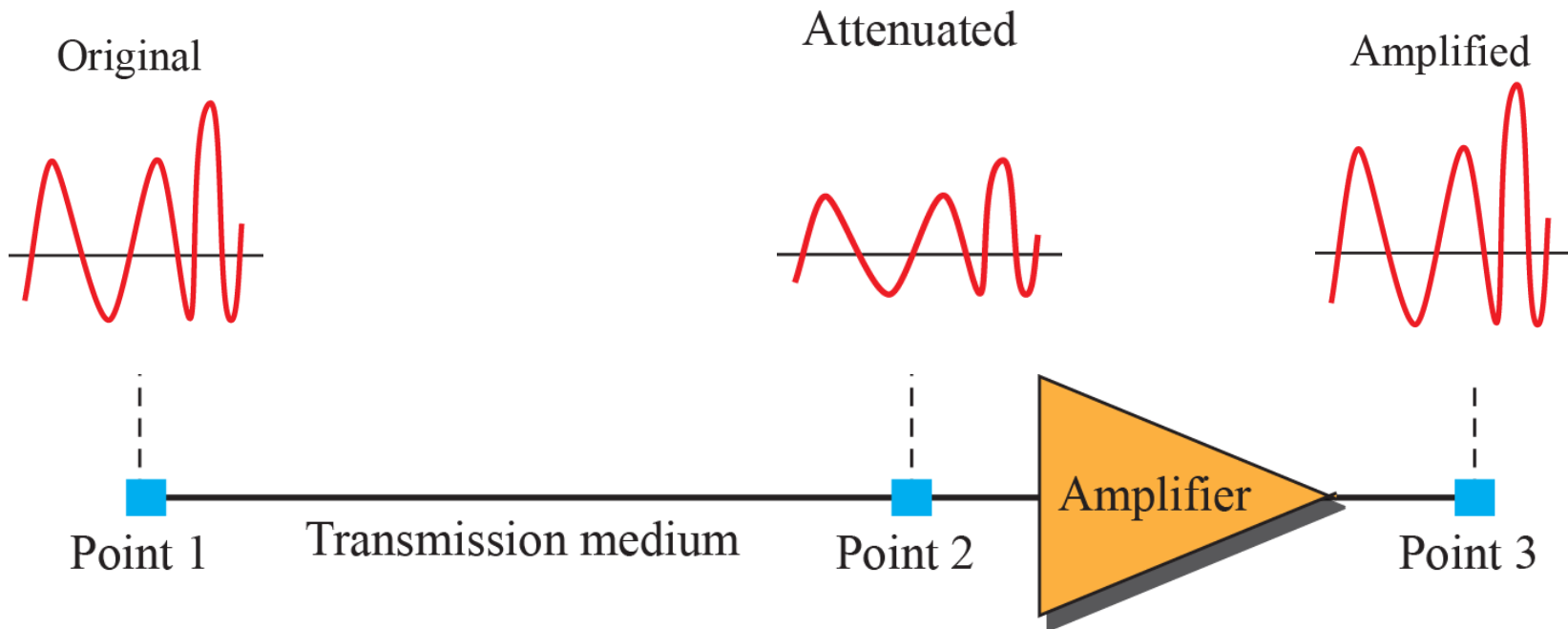
# Continued...



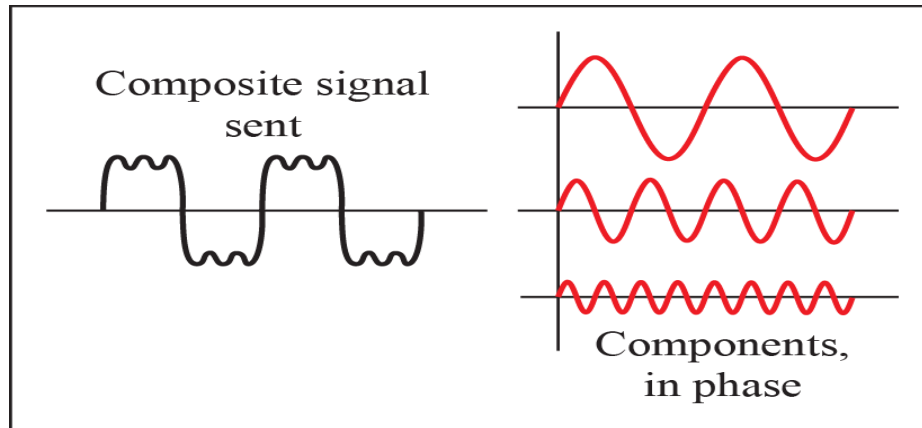
# Baseband and Broadband Transmission



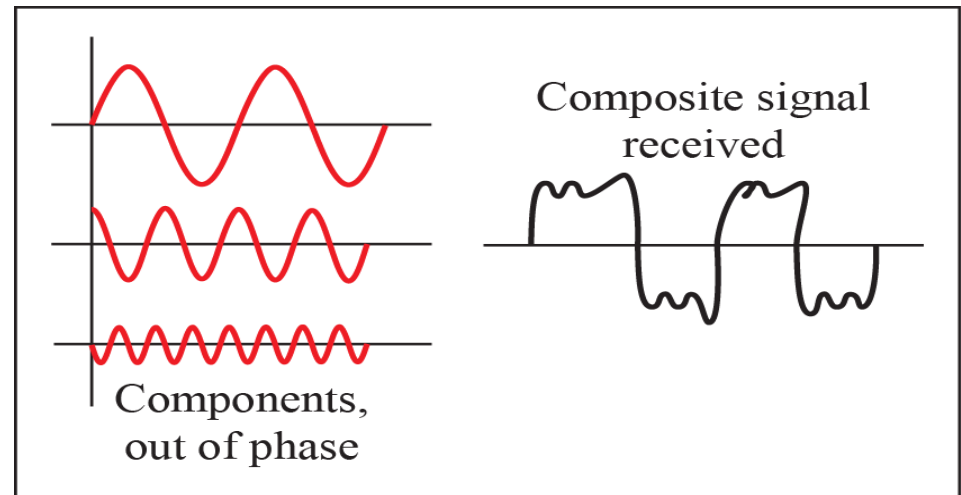
# Transmission Impairments: Attenuation



# Distortion

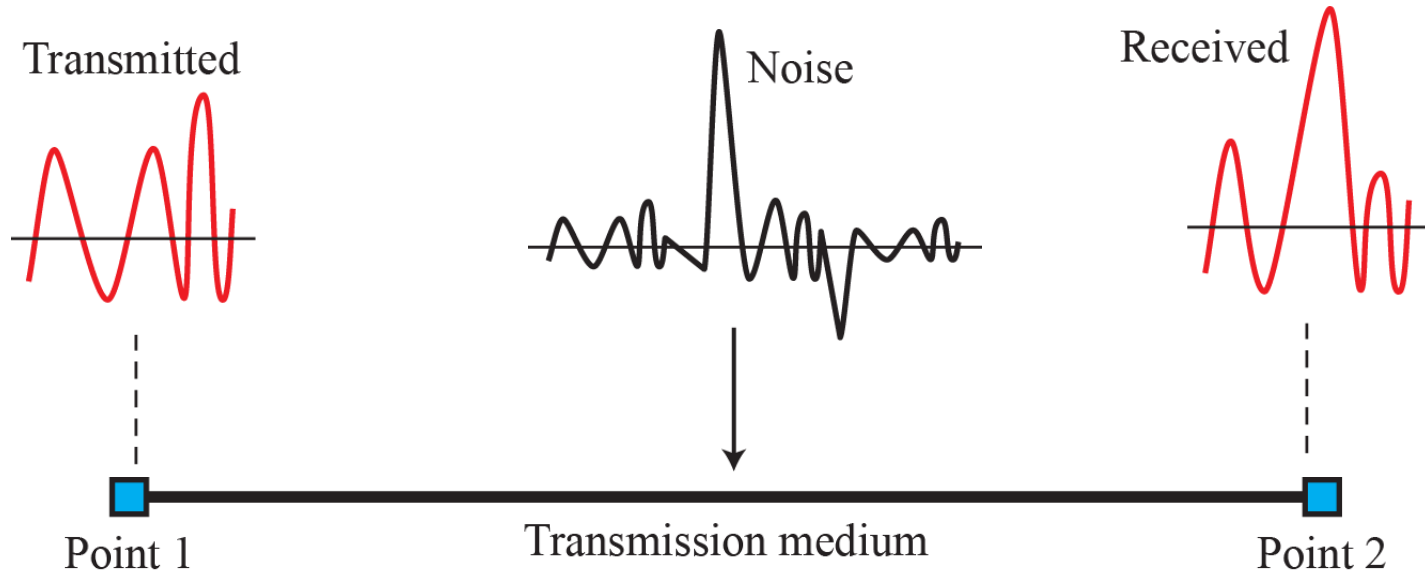


At the sender

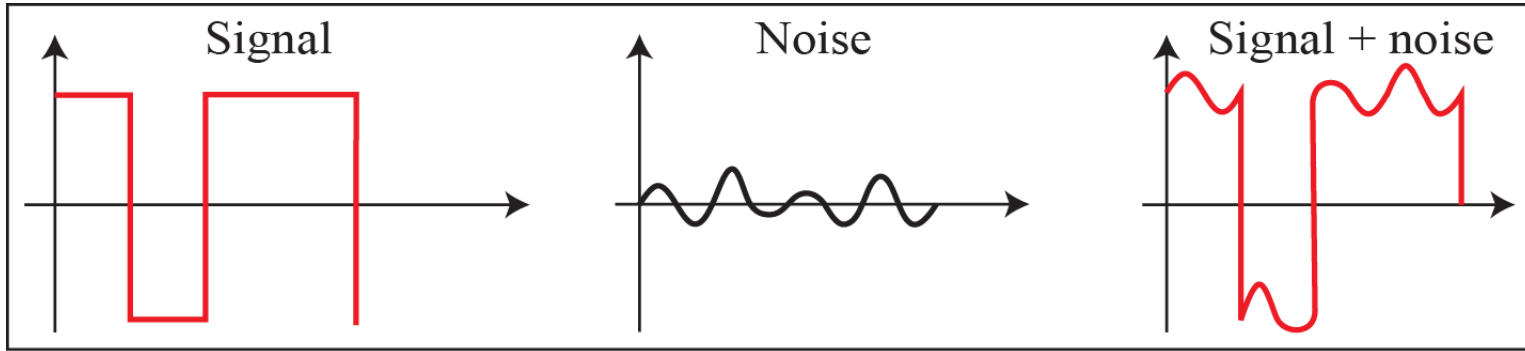


At the receiver

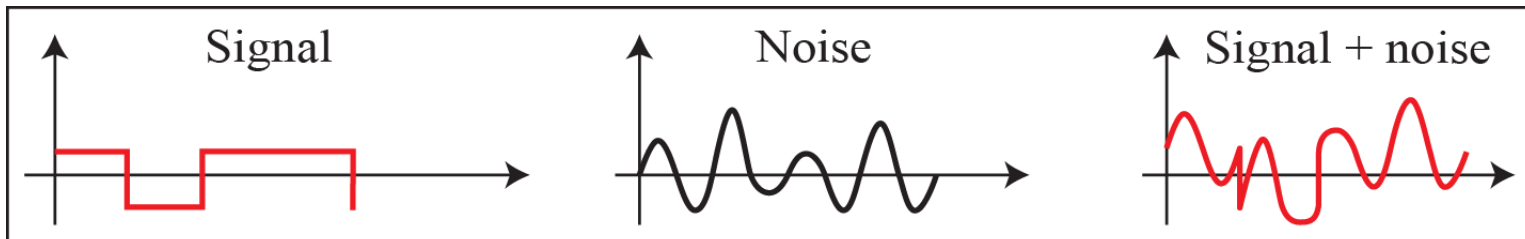
# Noise



# Signal to Noise Ratio (SNR)



a. High SNR



b. Low SNR