Review of Distortionless transmission

• Definition: \( y(t) \approx a \ x(t - \tau) \) (shape preserving)

• Necessary conditions for LTI systems with impulse response \( h(t) \): For desired set of frequencies
  • \(|H(f)| \approx a \) (magnitude of freq. resp. to be constant)
  • \( \angle H(f) \approx -2\pi f\tau \) (phase of freq. resp. to be linear through origin)

Signal design problem: \( h(t) \) given, design signals, \( x(t) \) so that \( y(t) \approx a \ x(t - \tau) \).
Modem design problem (Data transmission over the phone network)

- **Problem**
  - Message sequence of binary bits $b_1, b_2, \ldots$ every $T$ sec., rate is $1/T$ bps.
  - Signal design problem (modem design), (min. distortion)
    - **Pulse Amplitude Modulation (PAM):** $x(t) = \sum b_k p(t-KT)$
    - **Amplitude Shift Keying (ASK):**
      $$x(t) = \sum b_k p(t-KT) \cos(2\pi f_0 t)$$
    - **Phase Shift Keying (PSK):**
      $$x(t) = \sum p(t-KT) \cos(2\pi f_0 t + \Phi_k)$$
    - **Frequency Shift Keying (FSK):** $\sum p(t-KT) \cos(2\pi f_{b_k} t)$
  - Pulse shaping (minimize intersymbol interference)
  - Constellation design (binary or Mary)
Modem design problem continued

Distortionless bands:
Amplitude relatively constant: 300Hz – 3KHz
Phase approx. linear through origin: 1KHz -2.5KHz
Which signaling scheme to use

• PAM does not work. Why?
• Examine other signaling schemes.

ASK/OOK not generally used as unequal energy.

PSK and FSK used.
Solutions

• PSK: set $T = 1200\text{ bps.}, f_0 = 1750\text{ Hz}$
• FSK: two signals to transmit in $1500\text{ Hz}$ distortionless band; can get $T = 300\text{ bps.}, 600\text{ bps}.$
• How to get higher speed modems
  – Improved channels
  – Adaptive equalization
  – Multiple levels, use different constellations
• New technologies:
  – Asynchronous Digital Subscriber Line (ADSL): short lines under 3Km to central office, use DSP, downlink more than uplink
  – Cable modems, wireless networks, optical networks, internet, broadband