

**[10:30am] Analysis of 2-PAM**

---

- Transmitter sends bit of 1 (positive amplitude pulse) or zero (negative amplitude)
- Channel causes distortion
  - Spreading effect in time
  - Distortion in frequency
  - Intersymbol interference (ISI)
  - ISI can be mitigated with a guard period (wait between transmission of adjacent symbols)
  - ISI can also be mitigated using an equalizer
    - Adaptive filter can be trained using gradient descent or other methods
    - Cascade of channel and equalizer is ideal impulse (allpass)
- How to determine which bit was most likely to be sent?
  - Sample and threshold (compare to zero) is sensitive to additive noise
  - Averaging over the entire symbol period reduces the impact of noise
  - Correlating with the known pulse shape is the optimal choice (matched filter)
- Training sequence (such as PN sequence of chirp) can be used to train adaptive elements

**[11:15] Matched filter**

---

- Goal: detect pulse in presence of additive noise
- Model noise as additive, white, and Gaussian
- Output of matched filter is sampled at the symbol rate and thresholded
- For deterministic signal, the power spectra is simply the magnitude squared of the Fourier transform.
- For random signals, the power spectra is the Fourier transform of the autocorrelation
- Autocorrelation of gaussian random process with variance  $\sigma^2$  is  $\sigma^2 \delta(\tau)$