[11:20] Midterm #2 review (Lecture 26)

- Examine tradeoffs in implementation
  - Signal quality vs implementation complexity
  - Communication systems: Bit error rate vs. SNR
- FIR filters: always bounded-input bounded-output (BIBO) stable
- IIR filters: feedback of numerical error generally causes instability
  - Several structures: direct form, cascade of biquads, etc.
- Data conversion
  - Quantization: quantize to B bits, SNR = constant + 6B
  - Filter specifications can be derived from quantizer
- Resampling
  - Increase sampling rate: upsampler followed by lowpass filter to fill in zeros
    - Polyphase filter bank saves factor of L in run-time complexity
  - Decrease sampling rate: lowpass filter followed by downsampler
    - Polyphase filter bank saves factor of L in run-time complexity
- Communication systems

- Transmitter processing
  - Serial to parallel -> Constellation mapping -> Pulse shaping -> Modulation
- Receiver Processing
  - Demodulation -> Matched filter -> Decision device -> Parallel to serial
  - Decision device quantizes the received symbol amplitude to a symbol of bits
- Baseband channel model
  - Input -> Time-varying gain -> FIR filter -> Additive thermal noise -> Output
- QAM signal quality
  - Lower bound on symbol error probability for rectangular constellations:
    - Assume additive Gaussian noise as only impairment
    - Based on symbol error probability for 16-QAM
    - Argument of Q function depends on d, T_{sym}, σ

4-QAM

$$P(e) = 3Q\left(\frac{d}{\sigma}\sqrt{T_{sym}}\right) - \frac{9}{4}Q^2\left(\frac{d}{\sigma}\sqrt{T_{sym}}\right)$$

  - Tradeoff between bit rate, symbol error probability, and power consumption
    - Bit rate = $J f_{sym}$ where J is number of bits/symbol

QAM	Peak Power	Average Power	Peak-to-Average Power Ratio
4-QAM	$2d^2$	$2d^2$	1.00
8-QAM	$10d^2$	$6d^2$	1.67
16-QAM	$18d^2$	$10d^2$	1.80