

EE354 Learning Objectives

Lecture 1: Review of Statistics

1. Calculate the probability of an event, as well as joint and conditional probabilities of multiple events.
2. Describe what a random variable is and how it is defined.
3. Calculate the PDF and CDF of a random variable, and use these distributions to evaluate the probability of an event.

Lecture 2: Review of Statistics

1. Calculate the expected value of a function.
2. Evaluate the probability of error for a bit received in the presence of AWGN
3. Understand the concept of random processes and their properties, including autocorrelation, and crosscorrelation
4. Understand the difference between time averages and ensemble averages.

Lecture 3: Review of Fourier Series

1. Calculate the trigonometric and exponential Fourier coefficients.
2. Perform a Fourier series expansion of a function.

Lecture 4: Review of Fourier Transforms and δ Functions

1. Calculate the Fourier Transform and Inverse Fourier Transform of a function.
2. Understand the δ -function and how to apply its properties.
3. Evaluate the power spectral density of a signal.

Lecture 5: Review of Properties of Fourier Transform

1. Understand the fundamental properties of the Fourier Transform.
2. Apply the properties of the Fourier Transform to solve communications problems.

Lecture 6: Introduction to Communications

1. Describe the basic block diagram of a communication system.
2. Transition from linear units to dB units.
3. Determine the impact that distortion will have on a signal.
4. Calculate the output of a filter given the input signal and filter characteristic.

Lecture 7: Signals and Noise

1. Define Analog, Discrete, and Digital signals.
2. Describe the key elements in a communication system.
3. Determine the impact that noise will have on a signal and calculate the SNR.

Lecture 8: Sampling Theorem

1. Understand how the sampling theorem allows us to represent an analog signal as a discrete time signal.
2. Understand and apply the sampling theorem to determine Nyquist rate as well as the sampling rate of a system and frequencies present in the sampled spectrum.
3. Determine the frequencies present in a sampled spectrum when aliasing occurs.

Lecture 9: Quantization, A/D and D/A Conversion

1. Explain the difference between impulse, natural, and flat-top sampling.
2. Understand the three types of errors that occur in sampling and how they impact the sampled signal.
3. Understand how quantizing discretizes a signal in both time and amplitude, and calculate the number of bits required to achieve a specific SQNR.

Lecture 10: Shannon Capacity Theorem

1. Mathematically calculate the amount of information (entropy) contained in a message.
2. Calculate the information rate for a communication link.
3. Apply the Shannon Capacity formula to a particular communication channel and determine its maximum performance either in terms of information rate, bandwidth, or SNR.

Lecture 11: Pulse Amplitude Modulation

1. Explain the difference between Natural and Flat-Top Sampling.
2. Explain how Natural or Flat-Top Sampling is used to generate PAM signals.

Lecture 12: Time Division Multiplexing

1. Explain the difference between FDM, TDM, and CDM.
2. Explain conceptually how TDM operates.
3. Design a TDM system for a given number of signals with multiple different bandwidths/sampling frequencies.

Lecture 13: PWM, PPM, and Pulse Shaping

1. Explain the difference between PWM, PPM, and PAM.
2. Understand how pulse shapes contribute to intersymbol interference.

Lecture 14: ISI and Digital Signaling

1. Explain how ISI limits digital communications.
2. Understand the reason for using the Raised Cosine pulse shape.
3. Describe the different types of digital signaling (Polar/Bipolar, RZ, NRZ, AMI).
4. Map a series of bits into a specific digital signal.

Lecture 15: T-1 Communications and Delta Modulation

1. Understand the basic block diagram of T-1 Communications.
2. Calculate the bit rate requirements at any point in the T-1 Link.
3. Understand how Delta-Modulation differs from PCM.
4. Specify the parameters of a Delta Modulation system, including: Δ , f_s , and SQNR.

Lecture 16: Baseband Reception and Matched Filtering

1. Understand the difference between analog, discrete, and digital baseband receivers.
2. Design a simple baseband receiver for analog, discrete, or digital signals.
3. Understand the operation of the matched filter receiver.
4. Design a matched filter receiver for a digital signal set.

Lecture 17: Analog Baseband Performance

1. Explain how noise power / noise spectral density impacts the performance of an analog receiver.
2. Calculate the SNR for an arbitrary analog signal.
3. Calculate the performance of an analog receiver for an arbitrary signal in AWGN.

Lecture 18: Digital Baseband Performance

1. Explain the assumptions/conditions under which the matched filter receiver is the ideal receiver.
2. Describe the properties of AWGN and how they impact the performance of a digital receiver.
3. Calculate the SNR (E_b/N_0) of an arbitrary digital signal.

Lecture 19: Matched Filter Receiver

1. Describe the operation of the matched filter receiver.
2. Calculate the performance of a matched filter receiver for an arbitrary signal set in AWGN.
3. Calculate the performance of an analog receiver for an arbitrary signal in AWGN.

Lecture 20: Intro to AM Modulation

1. Describe the general form of an AM signal with transmitted/suppressed carrier component.
2. Determine the time domain and frequency domain representation of a DSB-TC and DSB-SC AM signal.
3. Calculate the bandwidth of an AM signal.
4. Understand and calculate the modulation index of an AM Signal

Lecture 21: AM Receivers

1. Describe mathematically how to demodulate AM signals.
2. Understand the conditions under which an envelope detector may be used.
3. Design either a coherent or incoherent AM demodulator.

Lecture 22: AM Performance

1. Calculate the power in the carrier and sidebands of an AM signal.
2. Understand the relationship between power (efficiency) and modulation index.
3. Calculate the envelope of an AM signal – maximum and minimum value.
4. Explain how to use AM to multiplex signals in the frequency domain.

Lecture 23: ASK Modulation and Demodulation

1. Explain how AM can be used to transmit digital signals.
2. Calculate the bandwidth, power, and data rate of an M-ary ASK communication system.
3. Understand and describe how to demodulate ASK signals through either a coherent or incoherent demodulator.
4. Explain how to use AM to multiplex signals in the frequency domain.

Lecture 24: ASK Performance

1. Design the matched filter receiver for an M-ary ASK signal set.
2. Calculate the SNR (E_b/N_0) for an M-ary signal set.
3. Calculate the BER/data rate of an M-ary ASK communication system.
4. Compare the performance of M-ary ASK communication systems for various values of M.

Lecture 25: Superheterodyne Receivers

1. Explain the fundamental reasons for the development of the superheterodyne receiver over the direct conversion receiver.
2. Understand the use of a variable local oscillator to downconvert a signal to a fixed IF.
3. Calculate the frequency of the variable local oscillator.
4. Calculate the value of the image frequency, explain the need for an image reject filter.