Summary of Learning Objectives

This is a list of the learning objectives for each lecture in the course.

Introduction to Data Communication

After this lecture you should be able to: define the terms introduced this lecture, be able to convert numbers between different number bases and bit/byte orders and convert between ASCII characters and their character codes.

Common Transmission Media

You should be able to: identify the different types of transmission media described in this lecture, their component parts and their advantages and disadvantages; compute common-mode and differential voltages; solve problems involving Z_0, velocity factor, ϵ_r,twisted pair and co-ax physical dimensions, and distributed L and C; solve problems involving signal levels and loss in logarithmic and linear units; convert between AWG and diameter; and solve problems involving free space propagation path loss.

Channel Characteristics and Impairments

After this lecture you should be able to: classify channels as high-, low-, or band-pass; use -dB and percentage power definitions of bandwidth; convert between delay and phase shift; compute group delay from phase response; identify some causes of multipath propagation and their effects on the channel frequency response; distinguish between linear- and non-linear distortion; compute the frequencies of IMD products for two-tone inputs; solve problems using equations for SNR, noise and signal powers, noise figure, noise temperature and bandwidth; compute the probability that a Gaussian source will exceed a certain value; identify sources of near-end, far-end and alien crosstalk; distinguish between noise and interference.

Serial Interfaces

After this lecture you should be able to: identify the purpose and signal voltages present on the data and handshaking signals; convert to/from the signal waveform and the data values transmitted; predict and explain the results of data rate and character format mismatches; explain advantages of differential "RS-422" serial interfaces.

Data Transmission over Bandlimited Channels

After this lecture you should be able to: determine if a channel meets the Nyquist no-ISI criteria and, if so, the maximum signalling rate without ISI; determine the maximum error-free information rate over an AWGN channel; determine the specific conditions under which these two limits apply; explain the principles of operation for partial-response signalling, decision-feedback equalization and sequence estimation. You should be able to perform computations involving the OFDM symbol rate, sampling rate, block size and guard interval.

Baseband Transmitters and Receivers

After this lecture you should be able to: explain two advantages of current loop signalling; define, calculate and explain the purpose for slew-rate limiting; compute the source and load impedances that avoid reflections; distinguish between passive and active terminations; compute noise margins; select and design the most appropriate bus driver technology for a bus with multiple drivers; list some functions of line drivers and receivers; explain how transformers can be used to: interface between balanced and unbalanced transmission lines, separate common-mode and differential signals, provide protection from DC or low-frequency AC; calculate transformer turns ratios for a given impedance or voltage ratio; explain the purpose for, and design an optoisolator circuit.

Line Codes

After this lecture you should be able to: distinguish between baseband and passband channels; explain reasons for use of bit stuffing; apply and remove bit stuffing; identify characteristics of a line code including: number of transitions per bit, number of levels, unipolar vs bi-polar, use of differential encoding, block vs bit-by-bit encoding, bandwidth, DC balance, maximum time between transitions; and encode/decode data to/from the line codes described below.

Framing

After this lecture you should be able to: determine if a data communication system requires framing or not, and choose between bit- and byte-oriented framing. You should be able to insert and remove escape sequences and bit stuffing from byte- and bit sequences respectively. For each of the framing techniques described in this lecture (line coding violations, byte escape sequences, and HDLC flags) you should be able to: write out a properly-framed bit- or byte-sequence, and extract the data sequence from a bit- or byte-sequence that contains framing information. You should be able to add and remove padding bits. You should be able to draw state transition diagrams for each of the framing techniques described below.

Error Detection and Correction

After this lecture you should be able to: list some advantages and disadvantages of checksums, compute even and odd parity bits, compute the Hamming distance between two code words, compute the code rate for block, punctured and non-punctured convolutional codes, correct errors in a received block code word by exhaustive search, compute coding gain, and compute the punctured output of a convolutional encoder.

Polynomials in GF(2) and CRCs

After this lecture you should be able to: represent a sequence of bits as a polynomial (with coefficients from GF(2)), compute the result of multiplying a polynomial by x^n, compute the result of dividing two polynomials, compute the value of a CRC given the message and generator polynomials, and determine if a CRC computation indicates an error has occured.

Ethernet LANs

After this lecture you should be able to: decide if a network is a LAN or PAN; compute the values of the fields of an 802.3 Ethernet frame; decide whether a bus or star LAN topology best meets specific requirements; identify the type of 802.3 LAN PHY according to the bit rate, number of pairs used, grade of cable and line code; specify the PHY parameters that would be chosen by autonegotiation between two Ethernet PHYs; specify the port(s) on which a frame will leave a learning bridge with and without VLANs configured; and choose disabled ports on interconnected bridges that will result in a spanning tree.

Internet Protocol

After this lecture you should be able to: differentiate between the Internet and IP; look up IP standards; interpret the values of the most common IP header fields; compute an IP checksum; determine the netmask for an IP network; determine if an IP address is in a particular network; determine if an IP address is public, private or link-local; decide which port a frame would be forwarded on based on the contents of a routing table; determine the effect on an ARP cache of receiving an 802.3-encapsulated IP frame; determine the IP source/destination addresses used on the public/private sides of a NAT router; list the recursive DNS queries used to resolve a domain name.

PN Sequences and Scramblers

After this lecture you should be able to: distinguish between random and pseudo-random signals, classify signals as PN, PRBS, and/or ML PRBS signals according to their quantization, periodicity, mean value and maximum run lengths, draw the schematic of a LFSR ML PRBS generator, explain two reasons why scrambling may be desirable, select between scrambling and encryption based on the need for secrecy, select between additive and multiplicative scramblers based on the availability of framing information, explain the error patterns resulting from erroneous input to a self-synchronizing scrambler, and implement (draw schematic of) additive scramblers and self-synchronizing multiplicative scramblers.

Modulation

After this lecture you should be able to: explain the purpose of modulation; list some advantages of digital modulation; write expressions for the time-domain signal, draw diagrams of the modulator, and draw constellation diagrams for: OOK, ASK, 4- and 8-PSK, m-ary QAM modulation; determine the spectrum of a modulated signal from the spectrum of the modulating signal, compute the frequencies of FSK, MSK and GMSK signals, and determine if constellations are Gray-coded.

Multiplexing and Multiple-Access Techniques

After this lecture you should be able to: classify a communication system as full-duplex, half-duplex or simplex; show how time and frequency are divided up between directions and users for TDD, FDD, TDMA, and FDMA; classify multiple-access techniques according to their suitability for constant-rate and bursty data; explain the shape of the graph of the Aloha throughput versus offered load.

ARQ and Flow Control

After this lecture you should be able to: explain how ACK frames ensure error-free transmissions; select an appropriate type of ARQ (from stop-and-wait, go-back-N and selective repeat) based on channel error rate and delay; and select appropriate flow-control method(s) to avoid over-flows.