Summary of Learning Objectives

This is a summary of the learning objectives for this course.

1 Introduction to Digital Communication

After this lecture you should be able to: define the terms introduced this lecture; compute information, entropy, bit, symbol, bit error and frame error rates; compute throughput; convert between characters, Unicode code points and their UTF-8 encodings; convert numbers between different number bases and bit and byte orders.

2 Asynchronous 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; distinguish between synchronous and asynchronous interfaces.

3 Common Transmission Media

After this lecture you should be able to: identify the different types of transmission media described in this lecture, their component parts and their advantages and disadvantages; 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.

4 Channel Characteristics and Impairments

After this lecture you should be able to: classify channels as high-, low-, or band-pass; determine -dB channel bandwidth and percentage power signal 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 frequencies of third-order IMD products; compute THD; compute SNR; 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.

5 Line Codes

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

6 Baseband Transmitters and Receivers

After this lecture you should be able to: compute noise margins and error rates for Gaussian noise; explain two advantages of current loop signalling; define, calculate and explain the purpose of slew-rate limiting; specify source and load impedances that avoid reflections; select and design the most appropriate bus driver technology for a bus with multiple drivers; list some functions of line drivers and receivers; justify a choice between polled and contention-based buses; 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; explain the purpose for, and design an optoisolator circuit.

7 Differential Signalling

After this lecture you should be able to: compute common-mode and differential voltages.

8 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 the BSC and AWGN channels; determine the specific conditions under which these two limits apply. You should be able to perform computations involving the OFDM symbol rate, sampling rate, block size and guard interval.

9 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 methods, 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.

10 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.

11 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 occurred. You should be able to determine if a CRC is guaranteed to detect a particular error sequence.

12 Ethernet LANs

After this lecture you should be able to: determine which of the first three OSI network layers defines specific functionality; 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.

13 *Duplexing and Multiple Access Not Covered*

14 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.