Summary of Learning Objectives

Introduction to Digital Communication

After this chapter you should be able to: define the terms introduced this chapter; 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.

Asynchronous Serial Interfaces

After this chapter 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.

Noise

After this chapter you should be able to: compute SNR and compute the probability that a Gaussian source will lie within a certain range.

Line Codes

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

Baseband Transmitters and Receivers

After this chapter you should be able to: compute noise margins and error rates for Gaussian noise; explain two advantages of current loop signalling; compute common-mode and differential voltages; 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.

Differential Signalling

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

Framing

After this chapter 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 chapter (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.

Polynomials in GF(2) and CRCs

After this chapter 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.

Error Detection and Correction

After this chapter 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.

PN Sequences and Scramblers

After this chapter 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.

Data Transmission over Bandlimited Channels

After this chapter 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.

Ethernet LANs

After this chapter you should be able to: compute the values of the fields of an 802.3 Ethernet frame.

Network Protocols

After this chapter you should be able to: label the protocol layers, PDU, SDU, peer layers and the flow of data through a protocol stack diagram; determine what data is seen by each layer of a protocol stack; determine which of the lowest four OSI protocol layers could provide a specific function; and decide if a network is a LAN or PAN.

Duplexing and Multiple-Access Techniques

After this chapter 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 throughput vs offered load curve for Aloha.

ARQ and Flow Control

After this chapter 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.