# Summary of Learning Objectives

## 1: 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 numbers between different number bases and bit and byte orders.

## 2: 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.

## 3: Character Encodings and Unicode

After this chapter you should be able to convert between characters, Unicode code points and their UTF-8 encodings.

## 4: 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.

## 5: Line Codes

After this chapter you should be able to: encode and decode data using the line codes described below and identify the advantages and disadvantages of each.

## 6: 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.

## 7: 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.

## 8: 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.

## 9: 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.

## 10: 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.

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

## 11: Ethernet LANs

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

## 12: Differential Signalling

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

## 13: 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.

## 14: 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.

## 15: ARQ

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