



Roll No

# National Institute of Technology Goa

Programme Name: B.Tech.

End Semester Examinations, December 2022

Course Name: Principles of Data Communications

Date: 05/12/2022

Duration: 3 Hours

Course Code: CS200

Time: 2.00 PM - 5.00 PM

Max. Marks: 100

## ANSWER ALL QUESTIONS

(a) Consider a packet-switching network of  $N$  nodes, connected by the following topologies:

- One central node; all other nodes attach to the central node.
- Each node connects to two other nodes to form a closed loop.
- Each node is directly connected to all other nodes.

For each case, give the average number of hops between stations. [3]

(b) What is the maximum bit rate of a noiseless channel with a bandwidth of 6000 Hz transmitting a signal with two signal levels? [3]

(c) Consider an extremely noisy channel in which the value of the signal-to-noise ratio is almost zero. Calculate the channel capacity. [4]

2. (a) Suppose an analog audio signal is sampled 10,000 times per second, and each sample is quantized into one of 1024 levels. What would be the resulting bit rate of the PCM digital audio signal? [5]

(b) A modified NRZ code known as enhanced-NRZ (E-NRZ) is sometimes used for high-density magnetic tape recording. E-NRZ encoding entails separating the NRZ-L data stream into 7-bit words; inverting bits 2, 3, 6, and 7; and adding one parity bit to each word. The parity bit is chosen to make the total number of 1's in the 8-bit word an odd count. What are the advantages of E-NRZ over NRZ-L? Any disadvantages? [5]

3. (a) What is frequency division multiplexing? How is interference avoided by using frequency division multiplexing? [3]

(b) Consider a transmission system using frequency division multiplexing. What cost factors are involved in adding one more pair of stations to the system? [3]

(c) A company has two locations: a headquarters and a factory about 25 km away. The factory has four 300-bps terminals that communicate with the central computer facilities over leased voice-grade lines. The company is considering installing TDM equipment so that only one line will be needed. What cost factors should be considered in the decision? [4]



4. (a) We send a digital signal from one station on a LAN to another station. Is this baseband or broadband transmission? Justify your answer. [3]
- (b) A noiseless 4-kHz channel is sampled every 1 msec. What is the maximum data rate? How does the maximum data rate change if the channel is noisy, with a signal-to-noise ratio of 30 dB? [3]
- (c) Suppose that  $N$  Ethernet stations, all trying to send at the same time, require  $N/2$  slot times to sort out who transmits next. Assuming the average packet size is 5 slot times, express the available bandwidth as a function of  $N$ . [4]

5. (a) What is the result of scrambling the sequence 11100000000110 using each of the following scrambling techniques? Assume that the last non-zero signal level has been positive. [5]

i. B8ZS

ii. HDB3 (The number of nonzero pulses is odd after the last substitution.)

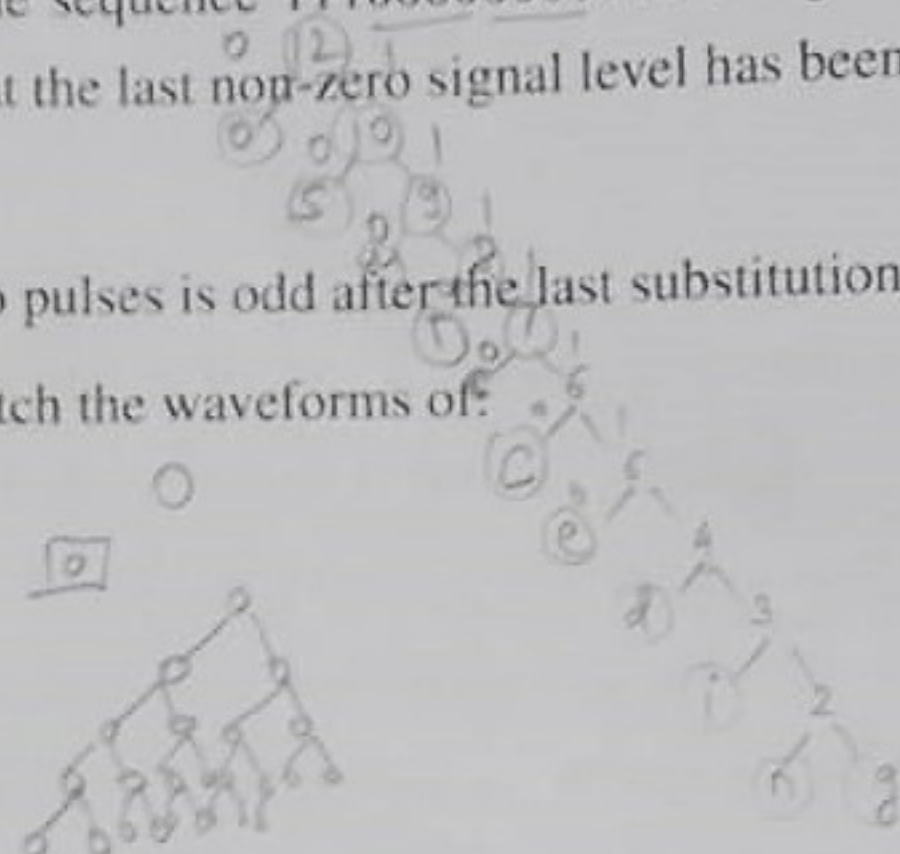
- (b) For the bit stream 1101010101, sketch the waveforms of:

i. NRZ-L

ii. NRZ-I

iii. Manchester

iv. Differential Manchester



6. (a) Describe the physical construction characteristics of the following transmission media. [3]
- i. Twisted pair
- ii. Coaxial cable
- iii. Optical Fibre cable

- (b) Describe the OSI seven layer model. Name each of the layers in the model and draw a diagram that shows the ordering of these layers. Discuss the functions that each layer is responsible for. Contrast the OSI model you have just described with the TCP/IP reference model. Using a diagram show the correspondence between relevant protocol layers in the two models. Discuss the relative merits of each of these models in the context of modern computer networking. [7]

7. (a) The source of information  $X$  generates the symbols  $\{x_0, x_1, x_2, x_3, x_4, x_5\}$  with the corresponding probabilities  $\{0.28, 0.12, 0.20, 0.05, 0.10, 0.25\}$ . Calculate the entropy and efficiency with Shannon Fano coding scheme. [5]

- (b) Encode the following text using Huffman Coding.

*Shannon Fano coding*

[5]

8. (a) Given the nondeterministic nature of CSMA/CD, why does it make sense to choose CSMA/CD as the MAC protocol of wired LANs and CSMA/CA for wireless LANs? [2]
- (b) How can hidden terminals be detected in 802.11 networks? [3]
- (c) Consider the message  $D = 1110011011$ , and pattern  $P = 100011$ . What is its 5 bit frame check sequence in CRC? [5]



9. (a) Show that the Internet checksum will never be 0xFFFF (that is, the final value of sum will not be 0x0000) unless every byte in the buffer is 0. (Internet specifications in fact require that a checksum of 0x0000 be transmitted as 0xFFFF; the value 0x0000 is then reserved for an omitted checksum. Note that, in ones complement arithmetic, 0x0000 and 0xFFFF are both representations of the number 0.) [5]
- (b) What is the value of checksum when the sender wants to transmit B617 55C1 B753 90DE? [5]
10. (a) Ethernet's CSMA/CD, upon detection of first-time collision, waits for some time before re-attempting transmission. How is this wait time chosen by every host/NIC? Among all the possible ways of choosing wait time, why is this method used? What happens when retransmission results in yet another collision? What about  $k$  consecutive collisions? [5]
- (b) What feature of wireless networks in indoor environments distinguishes it from outdoor environments? Suppose mobile device A is closer in proximity to a WLAN access point than another mobile device B. By the (inverse) quadratic distance rule of transmission power, can we conclude that A will achieve better reception/transmission? What actions may device B undertake (if feasible) to improve its throughput? [5]

\*\*\*ALL THE BEST\*\*\*

$$\begin{array}{r}
 \text{B617} \\
 + \text{B753} \\
 \hline
 \text{6D6A} \\
 \text{1} \\
 \hline
 \text{6D6B} \\
 + \text{55C1} \\
 \hline
 \text{C32C} \\
 + \text{90DE} \\
 \hline
 \text{540A} \\
 \text{1} \\
 \hline
 \text{540B}
 \end{array}$$

$$\begin{array}{r}
 \text{11} \\
 \text{ABF4} \\
 \text{B617} \\
 \hline
 \text{1420B} \\
 \text{1} \\
 \hline
 \text{420C} \\
 + \text{55C1} \\
 \hline
 \text{97CD} \\
 + \text{B753} \\
 \hline
 \text{14F20} \\
 \text{1} \\
 \hline
 \text{4F21} \\
 + \text{90DE} \\
 \hline
 \text{DFFF}
 \end{array}$$