CS 31204/31006: Computer Networks
Spring 2024

Full Marks: 15 | **Class Test 1, February 7, 2024** | **Time: 40 minutes**

NAME: **ROLL NO.:**

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1. Suppose that data has to be transmitted at the rate of 1 Gbps over a medium with a bandwidth of 250 MHz. The medium is noisy. What is the minimum SNR needed in dB? How many minimum signal levels are needed? No calculation needs to be shown. (1+1)

   11.76 dB (ok if between 11.6 to 11.9), 4

2. Suppose that an optical fiber with attenuation 0.2 dB/km is used to transmit digital signals over 100 km. If the transmitted power is 10 Watts and the minimum power needed for a receiver to sense a signal is 4 watts, minimum how many repeaters will be needed? No calculation needs to be shown (1)

   5

3. What 16-bit data pattern will cause the highest signaling rate if Manchester Encoding is used? Show the data pattern and draw the corresponding Manchester Encoding showing the bit intervals clearly. No explanation is needed. (2)

   All 0's or all 1's (mentioning any one is fine). See encoding from text.

4. Both block coding and scrambling replaces one bit pattern with another. What is the difference between the two? Do not explain what they are, identify the difference only. (2)

   Block Codes increase the number of transmitted but scrambling sends the same number of bits.

   Scrambling replaces the bit patterns after signal encoding is fully done just before transmission. Block codes replaces bit patterns in the data stream before further signal encoding is done.

   (Giving any one reason is fine)

5. What is piggybacking in the context of sending messages between a sender and a receiver? One sentence only. (1)

   Piggybacking refers to the process by which an acknowledgement for a frame sent from a sender S to a receiver R is sent by R inserted into a subsequent data frame sent from R to S, instead of sending the acknowledgement as a separate frame.

6. Consider an error detection scheme using a 16-bit checksum. What would be the checksum sent (in hex) for the data pattern (in hex) 5A3B77910DE1FFFF9EF2F3AB? Show your calculations. (2)

   Final answer is 8DB3 (1's complement of 724C). Calculations easy to do.

7. Consider a system using Stop-and-Wait ARQ. The frame size sent is 100 bytes. The bit error rate (probability that one particular bit is in error) is 0.001. Assume that bit errors are independent. Ack sizes are negligible. If the distance between sender and receiver is 1000 meters, propagation speed is 2×10^8 m/sec, date rate is 10 Mbps, what is the expected line efficiency? Show your calculations. You can directly use only the formula for line efficiency for Stop-and-Wait flow control taught in class if you want, derive anything else you use. (3)

   Frame will be in error if any one bit is in error. So probability of a frame being in error = 1 – probability that none of the bits are in error = $1 - (1 - 0.001)^{800} = 0.55$

Expected number of transmission of a frame before it is received successfully = 1 x (prob it is received in 1^{st} attempt + 2 x (prob it is received in 2^{nd} attempt) + ….

$= 1 \times (1 - 0.55) + 2 \times 0.55 \times (1 - 0.55) + 3 \times (0.55)^2 \times (1 - 0.55) + \ldots$

$= (1 - 0.55)\,[\,1 \times (0.55)^0 + 2 \times (0.55)^1 + 3 \times (0.55)^2 + \ldots.]$

$= (1 - 0.55)\,[\,1/(1 - 0.55)^2] = 1/0.45$

$= 2.22$

= 3 (taking ceiling, as expected no. cannot be fraction)

Line efficiency of Stop-and-Wait flow control = $800/[800 + 2 \times 10^7 \times 10^3/(2 \times 10^8)] = 0.88$

Therefore, line efficiency of Stop-and-Wait ARQ = 0.88/3 = 0.29 or 29% (between 29 and 30% is ok)

If no ceiling done, line efficiency will come to 0.88/2.22 = 0.39 or 39% (both 39% and 40% ok)

8. Consider a system using CSMA/CD. The maximum distance between any 2 machines can be 1.5 km, with a maximum of 2 repeaters in between. Each repeater, if used, introduces a delay of 2 microseconds. If the transmission speed is 100 Mbps, and the propagation speed is 2×10^8 m/sec, what is the minimum frame size required (in number of bytes)? Show you calculations, do not assume any formula. (2)

Maximum propagation delay between two machines = $(1.5 \times 10^3)/(2 \times 10^8) + 2 \times 2 \times 10^{-6}$ *sec.*

= 11.5 microseconds

If frame size is L bits, time (in microsecond) to transmit the frame = L/100

Sender should still be transmitting frame for 2 x max. propagation delay for collision to be detected

So $L/100 \geq 2 \times 11.5$*, or* $L \geq 2300$ *bits = 287.5 bytes = 288 bytes (as frame cannot have fraction of a byte)*