(100 points) 5 questions.

**Question 1:**
Consider a point-to-point link 2 km in length. At what bandwidth would propagation delay (at a speed of 2 \( \times \) \( 10^8 \) m/s) equal transmission delay for
(a) 100-byte packets?
(b) 512-byte packets?

**Question 2:**

![Diagram](image)

Hosts A and B are each connected to a switch S via 10-Mbps links as in the above figure. The propagation delay on each link is 20 \( \mu \)s. S is a store-and-forward device; it begins retransmitting a received packet 35 \( \mu \)s after it has finished receiving it.
Calculating the total time required to transmit 10,000 bits from A to B
(a) as a single packet
(b) as two 5000-bit packets sent one after the other

**Question 3:**
Show the NRZ, Manchester, and NRZI encodings for the bit pattern of 1001111100010001. Assume that the NRZI signal starts out low.

**Question 4:**

Part I: The following IP addresses are given in dotted-decimal notation. Write each of them in bitwise notation and give its class of address.
(a) 193.132.219.10
(b) 69.217.90.71

Part II: The following IP addresses are given in bitwise notation. Write each of them in dotted-decimal notation and give its class of address.
(c) 00010011.01101110.11111010.11111100
(d) 10011100.00000111.11100010.11101111
Question 5:
Suppose we want to transmit the message 11001001 and protect it from errors using the CRC polynomial $x^3 + 1$.
(a) Use polynomial long division to determine the message that should be transmitted.
(b) Suppose the leftmost bit of the message is inverted due to noise on the transmission link. What is the result of the receiver’s CRC calculation? How does the receiver know that an error has occurred?