1) 2-D Parity
Consider the following set of bits sent with 2-D even parity; the data bits are in the 4x4 upper-left block and the parity bits are in the rightmost column and bottom row. The given data has a 1-bit corruption.

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a) Which is the corrupted bit in the data given above?
b) Can 2-D parity be used to correct all 2 bit errors? Show examples or a counter-example for the answer.
c) What is the efficiency of this scheme?

2) CRC
Suppose we wish to transmit the following data: 1101 1001 1110. We are using \( x^4 + x^2 + 1 \) as the CRC generator.

a) What is the transmitted bit sequence (show your work)?
b) How large a burst of errors can be detected in this case?
c) Can this CRC be used detect all single-bit errors? What about double-bit errors?

3) Sliding Window
Suppose that we run the sliding window algorithm with SWS(Sender Window Size) = 6 and RWS(Receiver Window Size) = 4, and no out-of-order arrivals.

a) Find the smallest value for the “maximum sequence number”(N) to be used for successful transmission via Sliding Window algorithm.
b) Give an example showing that N – 1 is not sufficient for SWP, where N is the maximum sequence number calculated in part (a).
c) State a general rule for smallest maximum sequence number (N) in terms of SWS and RWS.

Assume that the sequence numbers are 0 based. So a max. seq. number = 4 means sequence numbers 0, 1, 2, 3 and 4 can be used.
4) **Sliding Window again**
Suppose SWS=RWS=4. The sender has 9 frames to send with sequence numbers 0, 1, 2, 3, 4, 5, 6, 7, 8 respectively with timeout = 4*RTT. Provide a comma separated list showing the order of packets sent by the sender, by sequence number (include packets lost in transit and any retransmissions) for the following cases:-
   a) Frame with sequence number 3 is lost.
   b) Frame with sequence numbers 3, 4, 5 and 7 are lost.

*Assume that ONLY the frames mentioned in each part are lost and ONLY during their first transmission. No other frame, ACK or retransmission is lost.*

5) **Spanning tree**
Given the extended LAN shown below, indicate which ports are not selected by the spanning tree algorithm.

![Spanning Tree Diagram](image)

6) **Learning bridge**
Consider the below network with bridges B1, B2, B3 and B4 with learning capability. All the nodes in the system have just booted up and all their forwarding tables are initially empty. Write down the forwarding tables of each bridge for the following sequence of events. Assume the events are in sequence and the tables from the previous step are retained.
a) B sends to C  
b) A sends to B  
c) E sends to A

7) IPv4 header  
Below is a diagram of the IPv4 header with its fields specified. As shown below, the width of each row is 32 bits (0-31).

An IPv4 packet is received at the destination. The IPv4 header of that packet has been mentioned below in network byte order. (The representation is in hexadecimal):
4500 0054 0000 4000 4001 7066 5014 010a 7620 0305

a) What is the IP header checksum value sent in this packet?  
b) Compute the header checksum for the packet using Internet checksum algorithm (show your work). Is there an error present in the header of the packet?  
c) Assuming the total length and header length fields to be error free, compute the length of the payload in this case? Show your work.  
d) Find the TTL. Compute the new checksum after decrementing the TTL by 1.