Instructions
1. Turn in a physical copy at the beginning of the class on 10/29
2. Ensure the HW cover page has the following information clearly written
   a. Name
   b. UCSD email
   c. PID

1. Sliding Window Protocol
   Suppose you are designing a sliding window protocol for a 4-Mbps point-to-point link that is $9 \times 10^4$ km long. Assuming each frame carries 4 KB of data, what is the minimum number of bits you need for the frame sequence numbers if
   a. RWS = 1
   b. SWS = RWS
   c. If we use the Stop-and-Wait ARQ protocol, what would be the maximum efficiency (defined as frames in transit/maximum possible frames in transit) that we can achieve?
   
   Assume that communication happens at the speed of light, that is $3 \times 10^8$ m/s

2. IP Checksum and Endianness
   a. The following IPv4 header, show in hex below, is received for an IP packet at its destination. Refer to the IPv4 header diagram below.

   4500 003c 1c46 4000 4017 c311 aca8 0101 aca8 0102

<table>
<thead>
<tr>
<th>IPv4 Header</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>Version</td>
</tr>
<tr>
<td>Identification</td>
</tr>
<tr>
<td>Time to Live</td>
</tr>
<tr>
<td>Source Address</td>
</tr>
<tr>
<td>Destination Address</td>
</tr>
</tbody>
</table>

   b. What is the header checksum? (You can find it by mapping the hex values to the IPv4 header diagram)
   c. Using the Internet checksum algorithm, determine if there were any errors in the transmission.
d. What would this packet which is network byte order look like when stored in the memory of a big-endian system? (Assume that the packet is stored in an array of (32-bit) integers in memory.)

e. How about in the memory of a little-endian system? (Again assume that the packet is stored in an array of integers in memory)

3. **CRC**
Suppose we want to transmit a message 1101 1001 0101 1001 and protect it from errors using the CRC generator \( x^8 + x^6 + x^3 + 1 \)

a. What is the CRC generator sequence? (The CRC generator polynomial represented in a bit sequence)

b. How many bits will the resulting frame check sequence be?

c. What is the transmitted bit sequence (show your work)?

d. How large a burst of errors can be detected?

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

![LAN Diagram](image-url)
5. **Sliding Window Timeline**

Consider a network where the sliding window protocol is in use with SWS = RWS = 2 frames and a one-way delay of 100 ms (i.e. for a frame sent at time t, it arrives at t + 100 ms). Assume that when multiple frames are all able to be sent according to the window size, that they are sent 20 ms apart (i.e., frame 1 starts at time t, and frame 2 starts at time t + 20 ms).

   a. What would be a reasonable timeout value for this link? Why not something smaller? How about larger?

   b. Now, assume that by sending a frame every 5 ms we can saturate the link. In this case, determine the smallest SWS and RWS that maximizes throughput (i.e., keeps the link fully utilized).

6. **2D Parity**

   a. Explain briefly why 2D parity can detect all 1-bit errors. Can the 1-bit errors be corrected?

   b. Why is the same true for 2-bit and 3-bit errors?

   c. Why can it not detect all 4-bit errors? Give an example of a 4-bit error that it can detect, and an example of a 4-bit error that it cannot detect.