1. John creates a novel and amazing network based on the Ethernet technology. All hosts within this network are in a single broadcast domain. Here’s information about his network:

- propagation delay: 30 milliseconds
- link capacity: 8 Megabits per second (Mbps)
- link length: 2.5 kilometers

(a) What is the RTT for this Network?

(b) What is the bandwidth delay product for his amazing new network?

(c) How does the bandwidth delay product change, if you double the link capacity?
2. Theo runs a very simple network, pictured below, with three switches and two hosts. The link capacity on each link is 10 Megabits-per-second, the propagation delay is 8 millisecond on each link. Assuming each packet can contain 250 bytes. Assume 0 queuing and 0 processing delay. Please include transmission delay in your calculations.

(a) How long will it take to send 5000 bytes if the network employs stop-and-wait? (The difference between the time the sender sends the first byte and receive the last ACK)

(b) What is the throughput for this network? (The throughput for sending these 5000 bytes)

(c) How long will it take to send 5000 bytes if the network employ sliding window? What is the size of the sending window (in packets)? Given this sending window size, how large should the sequence number be (in packets)?

(d) What is the throughput for this network? (The throughput for sending these 1000 bytes)
3. The Internet architecture has an hourglass shape where the Internet Protocol (IP) is the thin waist. What are the advantages of this hourglass architecture?

4. Consider the following bit sequence.
   1101 1110 1010 1101 1011 1110 1110 1111
   • Show the NRZ signal for the bit sequence.

   • Show the NRZI signal for the bit sequence.

   • Show the 4B/5B encoding, and the resulting NRZI signal, for the following bit sequence.

5. Show the 2D parity for the following bit sequence.
   1101111 0101011 0101011 1110111 1100010 1111000 1010100
6. Paul runs a small ISP, with 20 hosts, he goes to get an address for his ISP and he is given a class C address: \textbf{167.0.0.0}. How many addresses is Paul wasting by using a class C address for only 20 hosts? What is the percentage of wasted address?

7. Annoyed by the potential waste, Paul convinces the internet authorities to switch to CIDR. He is now given the following addresses: \textbf{128.23.0.0/24}. How many addresses is Paul wasting by using this CIDR address for only 20 hosts? What is the percentage of wasted address?

8. Convinced by Paul, the routers at the core also switch to CIDR. Below is the forwarding table for a router.

<table>
<thead>
<tr>
<th>Address</th>
<th>Next-Hop</th>
</tr>
</thead>
<tbody>
<tr>
<td>128.23.0.0/16</td>
<td>port 4</td>
</tr>
<tr>
<td>128.23.50.0/24</td>
<td>port 15</td>
</tr>
<tr>
<td>128.23.60.0/28</td>
<td>port 26</td>
</tr>
<tr>
<td>128.23.60.0/24</td>
<td>port 37</td>
</tr>
<tr>
<td>128.23.50.2/32</td>
<td>port 48</td>
</tr>
</tbody>
</table>

Given this forwarding table, what next-hop will the router use for packet from 128.23.40.2 to 128.23.50.8?