Do not open your blue book until you are told to begin.

- Write your name **legibly** on the top of each page of the exam and your blue book.
- You have 75 minutes to complete the exam.
- There is no leaving the room while taking the exam. If you think you might need to leave the room during the exam, you must do so **before** starting the exam.
- The exam has 20 questions, 100 points total.
- Not all points are created equal. Go for the easy points first!
- Make sure you have both pages of the exam before you begin.
- You may only use a pencil or a black- or blue-colored pen.
- The Rutgers policy on Academic Integrity applies to this exam.
- Show ALL work.
I. Quickies (24 points)
   1. Differentiate between packet switching and message switching.
      When sending a message across two links, the intermediary node must receive and buffer the full message
      before it can forward it. With packet switching, each packet in a message can be forwarded as soon as it is
      received.
      2. Explain the difference between the recursive and iterative methods of resolving DNS queries.
      In a recursive query, the responding server will perform future look-ups. In an iterative query, the local server
      performs all look-ups.
   3. In TCP, what is the difference between slow start versus starting the congestion window equal to the flow
      control window of the receiver?
      Using slow start means that the stream will gradually approach the congestion limit, easing network
      congestion while maximizing throughput. Without slow start, we can send at full speed based on the receiving
      host, but it could cause a large amount of congestion and packet loss.
      4. Differentiate among PUT, GET, and POST commands in HTTP.
      PUT – Uploads an object to the server.
      GET – Requests an object from a server, parameters are stored in the URL.
      POST – Requests an object from a server, parameters are stored in the message body.
   5. What is the difference between persistent and non-persistent HTTP connections?
      Persistent HTTP connections allow multiple objects to be requested over a single TCP connection. Non-
      persistent HTTP connections allow only a single object to be requested over a TCP connection.
   6. What are the advantages and disadvantages of a stateless HTTP server?
      A stateless HTTP server is easier to write, maintain, and guarantee. It also limits the functionality of such a
      server, because it is unable to tracker user sessions.

II. Network Performance (16 points)
   Calculate the total time required to transfer 1000KB file in the following cases. Assume an RTT of 100ms, a
   packet size of 1KB, and an initial 2xRTT of handshaking before data is sent.
   1. The bandwidth is 1.5Mbps, and data packets can be sent continuously.
      = 50ms + (8Mb/1.5Mbps) + 2*100ms
      = 250ms + 5.333s
      = 5.58333s
   2. The bandwidth is 1.5Mbps, but after we finish sending each data packet, we must wait one RTT before
      sending the next.
      = (50ms + 999*100ms) + (8Mb/1.5Mbps) + 2*100ms
      = 99.95s + 5.333s + 200ms
      = 100.15s + 5.333s
      = 105.48333s
   3. The bandwidth is infinite (meaning transfer delay is zero) and up to 20 packets can be sent per RTT.
      Prop. + (Trans. = 0) + Proto.
      = 100ms * (1000pkts/200pps) + 2*100ms + 5.2s
III. Internet Protocol (20 points)

<table>
<thead>
<tr>
<th>Subnet</th>
<th>Subnet Mask</th>
<th>Next Hop</th>
</tr>
</thead>
<tbody>
<tr>
<td>128.96.39.0</td>
<td>255.255.255.128</td>
<td>L1</td>
</tr>
<tr>
<td>128.96.39.128</td>
<td>255.255.255.128</td>
<td>L2</td>
</tr>
<tr>
<td>128.96.40.0</td>
<td>255.255.255.128</td>
<td>L3</td>
</tr>
<tr>
<td>192.4.153.0</td>
<td>255.255.255.192</td>
<td>L4</td>
</tr>
<tr>
<td>default</td>
<td></td>
<td>L5</td>
</tr>
</tbody>
</table>

Given the routing table above, describe which links the packet will be routed on for the following destination addresses:

1. 128.96.39.10 → L1
2. 128.96.40.12 → L3
3. 128.96.40.151 → L5
4. 192.4.153.17 → L4
5. 192.4.153.90 → L5

IV. IP Subnetting (20 points)

Mycompany.com has been given a class C address, 200.2.2.0/24, and wants to form three subnets to support three departments. Show the subnet masks and a representative IP address for each subnet with a network arrangement where the number of hosts within each department is as follows:

- Dept. A: 72 hosts
  - 200.2.2.0 | 255.255.255.128
- Dept. B: 35 hosts
  - 200.2.2.128 | 255.255.255.192
- Dept. C: 40 hosts
  - 200.2.2.192 | 255.255.255.192

V. Transport Control Protocol (20 points)

Packets 1 to 32 need to be sent using TCP. How many RTTs does it take to send all packets under the following circumstances?

1. Without slow start; with flow control window equal to 16 packets; no packets are lost.
   \[16 + 16 = 2 \text{ RTTs}\]
2. With slow start; with flow control window equal to 16 packets; no packets are lost.
   \[1 + 2 + 4 + 8 + 16 + 1 = 6 \text{ RTTs}\]
3. With slow start; with flow control window equal to 16 packets; packet 4 is lost, but eventually retransmitted with no other packet loss.
   \[1 + 2 + 3 + 1 + 2 + 4 + 8 + 11 = 8 \text{ RTTs}\]
4. With slow start; SS-threshold = 8; no packets are lost.
   \[1 + 2 + 4 + 8 + 9 + 8 = 6 \text{ RTTs}\]
5. With slow start; SS-threshold = 8; packet 4 is lost, but eventually retransmitted with no other packet loss.
   \[1 + 2 + 3 + 1 + 2 + 4 + 8 + 9 + 2 = 9 \text{ RTTs}\]