Note 1: All parts of the assignment are to be completed independently.

Note 2: Your solutions/results/write-ups from parts 1 and 2 should be stapled and turned in together to the homework box.

**Part 1:** Complete the questions on the following pages. (70 points total)

**Part 2:** Ethereal Lab (30 points total)

Complete the Ethereal Lab on IP in the attached handout. The turn-in requirements are listed on the handout.
**Homework 4 Questions**

1. Consider a datagram network using 32-bit host addresses. Suppose a router has four links, numbered 0 through 3, and packets are to be forwarded to the link interfaces as follows:

<table>
<thead>
<tr>
<th>Destination Address Range</th>
<th>Link Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>10100000 00000000 00000000 00000000 through 10100000 11111111 11111111 11111111</td>
<td>0</td>
</tr>
<tr>
<td>10100001 00000000 00000000 00000000 through 10100001 00000000 11111111 11111111</td>
<td>1</td>
</tr>
<tr>
<td>10100001 00000001 00000000 00000000 through 10100001 11111111 11111111 11111111</td>
<td>2</td>
</tr>
<tr>
<td>Otherwise</td>
<td>3</td>
</tr>
</tbody>
</table>

(a) Provide a forwarding table that has four entries, uses longest-prefix matching, and forwards packets to the correct link interfaces.

(b) What is the correct interface to use for each of the following addresses:
- 10001000 10010001 01010001 01010101
- 10100001 00000000 11000011 00111100
- 10100001 10000000 00010001 01110111

(c) Rewrite the forwarding table you created for part (a) using the a.b.c.d/x notation instead of the binary string notation.

2. Consider the topology shown in Figure 4.17 of your textbook. Denote the three subnets with hosts (starting clockwise at 12:00) as Networks A, B, and C. Denote the subnets without hosts as Networks D, E, and F.

(a) Assign network addresses to each of these six subnets, with the following constraints:
- All addresses must be allocated from 214.97.254/23;
- Subnet A should have enough addresses to support 250 interfaces;
- Subnet B should have enough addresses to support 120 interfaces;
- Subnet C should have enough addresses to support 120 interfaces;
- Subnets D, E and F should each be able to support two interfaces.

For each subnet, the assignment should take the form a.b.c.d/x or a.b.c.d/x – e.f.g.h/y

(b) Using your answer to part (a), provide the forwarding tables (using longest prefix matching) for each of the three routers.
3. Consider the network in Figure 4.20 of your textbook. Suppose that the ISP instead assigns the router the address 126.13.89.67 and that the network address of the home network is 192.168/16.
(a) Assign addresses to all interfaces in the home network.
(b) Suppose each host has two ongoing TCP connections, all to port 80 at host 128.119.40.86. Provide the six corresponding entries in the NAT translation table.

4. Now let’s think about the impact of NATs on P2P applications. Suppose a peer with user name Anne discovers through querying that a peer with user name Bob has a file she wants to download. Also suppose Bob is behind a NAT whereas Anne isn’t. Let 138.76.29.7 be the WAN-side address of the NAT and let 10.0.0.1 be the internal IP address for Bob. Assume that the NAT is not specifically configured for the P2P application. Discuss why Anne’s peer cannot initiate a TCP connection to bob’s peer, even if Anne know the WAN-side address of the NAT, 138.76.29.7.

5. Consider the following network. With the indicated link costs, use Dijkstra’s shortest-path algorithm to compute the shortest path from x to all network nodes. Show how the algorithm works by computing a table similar to Table 4.3 in your book.
6. Consider the network fragment in the figure below. x has only two attached neighbors, w and y. w has a minimum-cost path to destination u (not shown) of 5, and y has a minimum-cost path to u of 6. The complete paths from w and y to u (and between w and y) are not shown. All link costs in the network have strictly positive integer values.

![Network Fragment](image)

(a) Give x’s distance vector for destination w, y, and u.
(b) Give a link-cost change for either c(x,w) or c(x,y) such that x will inform its neighbors of a new minimum-cost path to u as a result of executing the distance vector algorithm.
(c) Give a link-cost change for either c(x,w) or c(x,y) such that x will *not* inform its neighbors of a new minimum-cost path to u as a result of executing the distance vector algorithm.

7. Consider the network shown in Figure 4.41 of your book. Suppose that all links have unit cost and that node E is the broadcast source. Redraw the figure, and using arrows such as those shown in Figure 4.41, indicate links over which packets will be forwarded using RPF, and links over which packets will not be forwarded, given that node E is the source.

8. Suppose a router has the following table:

<table>
<thead>
<tr>
<th>Subnet Number</th>
<th>Subnet Mask</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>128.96.39.0</td>
<td>255.255.255.128</td>
<td>0</td>
</tr>
<tr>
<td>128.96.39.128</td>
<td>255.255.255.128</td>
<td>1</td>
</tr>
<tr>
<td>128.96.40.0</td>
<td>255.255.255.128</td>
<td>2</td>
</tr>
<tr>
<td>192.4.153.0</td>
<td>255.255.255.192</td>
<td>3</td>
</tr>
<tr>
<td>Default</td>
<td>255.255.255.192</td>
<td>4</td>
</tr>
</tbody>
</table>

Indicate on which interface the router forwards a packet addressed to each of the following destinations:

- 128.96.39.10
- 128.96.40.12
- 128.96.40.151
- 192.4.153.17
- 192.4.153.90
9. Consider the following simple network, in which A and B exchange distance-vector routing information.

![Network Diagram]

All links have cost 1. Suppose the A-E link fails. Give a sequence of routing table updates that leads to a routing loop between A and B.

10. Read the man page or other documentation for the Unix/Windows utility `netstat`. Use `netstat` to display that current IP routing table on your host. Print the table, and explain the purpose of each entry. What is the practical minimum number of entries?