1. Consider the network shown below. Enumerate all the paths from $A$ to $F$ that do not contain any loops. For each path you list give the cost of the path.

\begin{center}
\begin{tikzpicture}
  \node[circle, draw] (A) at (0,0) {$A$};
  \node[circle, draw] (B) at (2,2) {$B$};
  \node[circle, draw] (C) at (4,2) {$C$};
  \node[circle, draw] (D) at (2,0) {$D$};
  \node[circle, draw] (E) at (4,0) {$E$};
  \node[circle, draw] (F) at (6,2) {$F$};

  \draw[->, thick] (A) -- node[above] {1} (D);
  \draw[->, thick] (D) -- node[midway, above] {2} (B);
  \draw[->, thick] (B) -- node[above] {3} (C);
  \draw[->, thick] (C) -- node[above] {5} (F);
  \draw[->, thick] (F) -- node[above] {5} (E);
  \draw[->, thick] (E) -- node[below] {1} (D);
  \draw[->, thick] (D) -- node[below] {3} (B);

\end{tikzpicture}
\end{center}

2. Consider the network fragment shown below. Switch $X$ has only two attached neighbors, $W$ and $Y$. $W$ has a minimum-cost path to destination $A$ (not shown) of 5, and $Y$ has a minimum-cost path to $A$ of 6. The complete paths from $W$ and $Y$ to $A$ (and between $W$ and $Y$) are not shown. All link costs in the network have strictly positive integer values.

\begin{center}
\begin{tikzpicture}
  \node[circle, draw] (W) at (2,3) {$W$};
  \node[circle, draw] (X) at (1,1) {$X$};
  \node[circle, draw] (Y) at (3,1) {$Y$};

  \draw[->, thick] (W) -- node[above] {1} (X);
  \draw[->, thick] (X) -- node[above] {4} (Y);
\end{tikzpicture}
\end{center}
a) Give $X$’s distance table (row) entries for destinations $W$, $Y$, and $A$.

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 $A$ as a result of executing the distance vector algorithm in the text.

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 $A$ as a result of executing the distance vector algorithm.

3. Consider the simple network shown below, in which $A$ and $B$ exchange distance-vector routing information. All links have cost 1. Suppose A-E link fails.

![Network Diagram]

a) Give a sequence of routing table updates that leads to a routing loop between $A$ and $B$.

b) Estimate the probability of the scenario in (a), assuming $A$ and $B$ send out routing updates at random times, each at the same average rate.

c) Estimate the probability of a loop forming if $A$ broadcasts an updated report within 1 second of discovering the A-E failure, and $B$ broadcasts every 60 seconds uniformly.

4. Compute the distance tables for $X$, $Y$, and $Z$ shown in the rightmost column of the table below. After computation of the new distance tables, which nodes will send which updated values to which neighbors?

![Distance Table]

5. 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>11100000 00000000 00000000 00000000 through 11100000 00000000 00000000 00000000</td>
<td>0</td>
</tr>
<tr>
<td>11100000 11111111 11111111 11111111</td>
<td></td>
</tr>
<tr>
<td>11100001 00000000 00000000 00000000 through 11100001 00000000 11111111 11111111</td>
<td>1</td>
</tr>
<tr>
<td>11100001 11111111 11111111 11111111</td>
<td></td>
</tr>
<tr>
<td>11100001 000000001 00000000 00000000 through 11100001 000000001 00000000 00000000</td>
<td>2</td>
</tr>
<tr>
<td>11100001 11111111 11111111 11111111</td>
<td></td>
</tr>
<tr>
<td>otherwise 11100001 00000000 11000011 00111100</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. Specify this table in both types of notation: binary string notation as well as the a.b.c.d/x notation.

b) Describe how your forwarding table determines the appropriate link interface for datagrams with destination addresses:

- 11001000 10010001 01010001 01010101
- 11100001 00000000 11000011 00111100
- 11100001 10000000 00010001 01110111

6. Consider a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3. Suppose all of the interfaces in each of these three subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet 1 is required to support up to 125 interfaces, and Subnets 2 and 3 are each required to support up to 60 interfaces. Provide three network addresses (of the form a.b.c.d/x) for these subnets that satisfy these constraints.