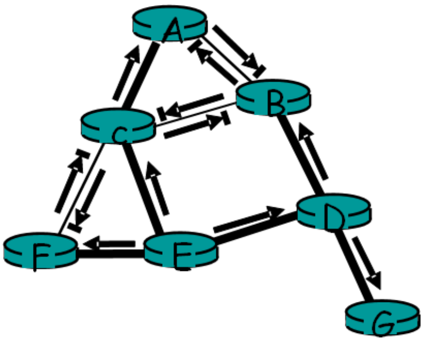
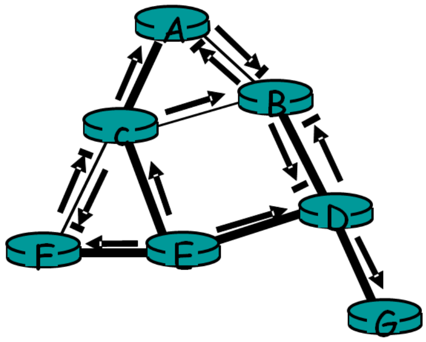
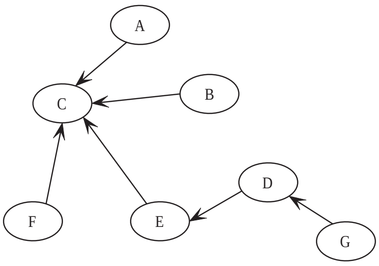
CSE 677: Solution for HW 4

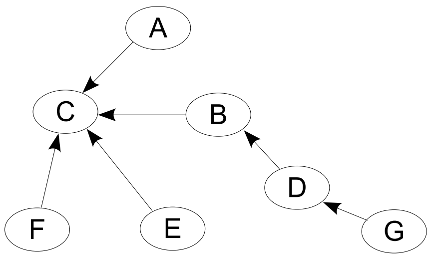
1. See the figures.





2. The resulting tree is a minimum cost spanning tree because any spanning tree will include 7 - 1 = 6 links. Number of links = Number of nodes -1 in a tree. As the cost is 1 for each link, the any minimum cost spanning tree will have a cost of 6. And the cost of the constructed center-based tree is also 6.





3. Refer to the result below:

```
1 0 1 0 | 0
0 1 0 1 | 0
1 0 1 0 | 0
0 1 0 1 | 0
--------|---
0 0 0 0 | 0
```

   A sequence of 9 0's is the parity.

4. (a) No matter how you place the 3 bits in a matrix, there will always be 1 row or 1 column with only 1 of those 3 bits. That row or column will have a parity error. Therefore, all 3-bit errors will be detected.

   (b) In order to correct, all the 3 bit locations have to be uniquely identified. Observe that the total number of rows with parity errors, will be either 1 or 3. It will be 1 if the 3 bits are in the same row or if 1 is in one row and the other 2 are in a different row. It will be 3 if the bits are in three different rows. The same holds for columns as well. So, there are three 4 possibilities:

   - **1 column in error and 1 row in error:** For example, (1,1) (2,1) (2,2) and (1,3) (2,3) (2,2) can't be distinguished.
   - **3 columns in error and 3 rows in error:** For example, (1,1) (2,2) (3,3) and (1,3) (2,2) (3,1) can't be distinguished.
   - **1 row in error and 3 columns in error:** For example, (1,1) (1,2) (1,3) and (1,1) (2,2) (2,3) can't be distinguished.

- **1 column in error and 3 rows in error:** similar to above.

Therefore, no 3-bit error can be corrected.

5. Refer to the work below:

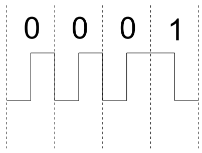
```
    r = |G| - 1 = 3
    R = remainder(D*2^r/G)

       1 1 1 0 0 0 1 1
     -----------------------
1110 | 1 0 1 0 1 0 1 0 0 0 0
       1 1 1 0 . . . . . . .
       ------- . . . . . . .
         1 0 0 1 . . . . . .
         1 1 1 0 . . . . . .
         ------- . . . . . .
           1 1 1 0 . . . . .
           1 1 1 0 . . . . .
           ------- . . . . .
                   1 0 0 0 .
                   1 1 1 0 .
                   ------- .
                     1 1 0 0
                     1 1 1 0
                     -------
                       0 1 0

    R = 010
```

So the bit stream that is transmitted is 1 0 1 0 1 0 1 0 0 1 0.

6. See the figure.



- The clocks of sending and receiving interfaces are not perfectly synchronized, but with using Manchester encoding the receiver can easily determine wether a bit is 1 or 0 by checking the transition of the signal at the middle point.
- While the sender is sending consecutive 0s, the receiver cannot determine whether the sender is sending 0s or nothing without encoding. Also, with time clock falls out of synchronization. So a long sequence of 0's may get mis-counted.

7. We want $1/(1+5a) = .5$ or, equivalently, $a = .2 = t_{prop}/t_{trans}$.

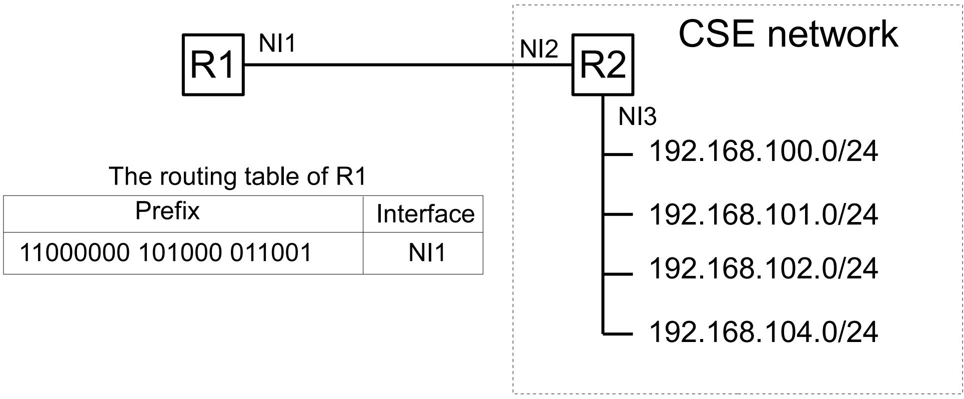
   $t_{prop} = d/(2 \times 10^8)$ m/sec and $t_{trans} = (64 \times 8 + 64)/(10^8 bits/sec) = 5.76\mu$ sec. Solving for d we obtain $d = 230.4$ meters.

8. A supernet is an Internet Protocol (IP) network that is formed from the combination of two or more networks (or subnets) with a common Classless Inter-Domain Routing (CIDR) prefix. CIDR is a method for allocating IP addresses, in which an IP address consists of two parts. The significant part represents a network address that identifies a network or a subnet; the least significant part represents a host identifier. This allows us to allocate IP addresses with variable length prefix. For example, in 192.168.0.0/16, the 16-bit prefix shows the network and the 16-bit suffix shows the host. Supernetting is the process of aggregating routes to multiple smaller networks, and therefore reduces routing overhead such as storage cost of a routing table and routing decision.

   Example: Consider that the CSE network has 4 sub-networks with the network addresses 192.168.100.0/24, 192.168.101.0/24, 192.168.102.0/24, and 192.168.103.0/24, as shown bellow. Without supernetting, the router $R1$ will have four entries for each network that the CSE has. Supernetting can aggregate these four sub-networks, since they has the common CIDR prefix as follow:

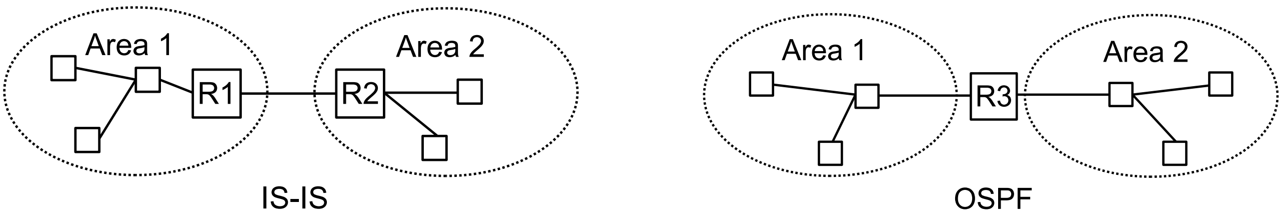
192.168.100: 11000000 101000 01100100
192.168.101: 11000000 101000 01100101
192.168.102: 11000000 101000 01100110
192.168.103: 11000000 101000 01100111
(The common prefix is 11000000 101000 011001.)

Therefore, router $R1$ needs to have only one entry,(192.168.100, Network Interface 1) , as shown in the figure.



9. **Similarities**
   - Both of them are link state routing protocols and use Dijkstra's algorithm to compute paths.
   - Both support variable length subnet masks, can use multicast to discover neighboring routers using hello packets, and can support authentication of routing updates.

   Differences
   - IS-IS routers belong to exactly one area, while OSPF routers can belong to multiple areas. To be specific, in IS-IS, areas are categorized into either Level 1 (Intra-area) or Level 2 (Inter-area). Routers are designed for Level 1, Level 2, and the two different level are bridged by Level 1-2 routers (note that bridging intra and inter-areas(Level 1 and 2 areas) does not mean a Level 1-2 router belongs to two areas). The border of two different areas is between Level 2 or 1-2 routers, and so inter-traffic must pass them.
   - While OSPS uses explicit ACKs to distribute link state information when updated, IS-IS uses the complete sequence number (CSNP). In OSPF, link state information is flooded by broadcasting neighboring routers, and the receivers reply an ACK. If the sender dose not receive the ACK for the timeout interval, it retransmits the link state information. On the other hand, IS-IS does not use ACKs. Instead, link state databases are updated by periodic CSNP exchanges that contains packet ID, sequence number, checksum, and lifetime.



10. Refer to the output below:

```
lo0: flags=1000849<UP,LOOPBACK,RUNNING,MULTICAST,IPv4> mtu 8232 index 2
    inet 127.0.0.1 netmask ff000000
ce0: flags=1000843<UP,BROADCAST,RUNNING,MULTICAST,IPv4> mtu 1500 index 3
    inet 164.107.112.41 netmask ffffff00 broadcast 164.107.112.255
```

"ifconfig -a" prints the interface information for all interfaces in the system, such as interface name, flags, mtu, index, IP address, netmask and broadcast address, etc.

Refer to the output below:

```
Net to Media Table: IPv4
Device   IP Address               Mask      Flags   Phys Addr
------ -------------------- --------------- ----- ---------------
ce0    nas-dl.cse.ohio-state.edu 255.255.255.255       00:60:16:06:41:5d
ce0    kappa.cse.ohio-state.edu 255.255.255.255       00:03:ba:2c:d0:32
```

```
ce0    hsrp112.cse.ohio-state.edu 255.255.255.255       00:23:9c:46:f2:00
ce0    filehost9.cse.ohio-state.edu 255.255.255.255       00:50:56:95:6d:b9
ce0    cs2.cse.ohio-state.edu 255.255.255.255       00:13:72:5a:c2:d0
ce0    cs1.cse.ohio-state.edu 255.255.255.255       00:13:72:5a:c7:e5
ce0    backup-tsm.cse.ohio-state.edu 255.255.255.255       00:23:ae:ff:50:3a
ce0    dc1.cse.ohio-state.edu 255.255.255.255       00:19:b9:e1:58:a1
ce0    emcwin.cse.ohio-state.edu 255.255.255.255       00:50:56:95:0c:0e
ce0    nas-dl-cs.cse.ohio-state.edu 255.255.255.255       00:0e:0c:74:38:8c
ce0    storage-cl-spb.cse.ohio-state.edu 255.255.255.255       00:60:16:01:6e:13
ce0    storage-cl-spa.cse.ohio-state.edu 255.255.255.255       00:60:16:01:6e:33
ce0    mu.cse.ohio-state.edu 255.255.255.255 SP    00:03:ba:2c:d3:2e
ce0    presto.cse.ohio-state.edu 255.255.255.255       00:1e:c9:e9:31:27
ce0    testdb.cse.ohio-state.edu 255.255.255.255       00:50:56:95:2f:59
ce0    filehost678.cse.ohio-state.edu 255.255.255.255       00:50:56:95:1d:03
ce0    fl1.cse.ohio-state.edu 255.255.255.255       00:13:72:54:c8:38
ce0    base-address.mcast.net 240.0.0.0       SM    01:00:5e:00:00:00
```

"arp -a" display all of the current ARP entries in the Internet-to-Ethernet address translation tables used by the address resolution protocol. The information includes device name, IP address, mask, flags and physical address. The flag "S" stands for static, not learned for the ARP protocol. The flag "M" stands for mapping, only used for the multicast entry for 224.0.0.0.

11. See the tables.

Table 1: Switch table of S1

MAC Address	Interface	Time
R_{11}	S_{12}	∞

Table 2: Switch table of S2

MAC Address	Interface	Time
B_1	S_{23}	∞
R_{14}	S_{22}	∞

A switch is a Layer 2 device, and so an entry consists of a MAC address and the corresponding interface. Since we assume that the router knows all routes and the source nodes send one packet, there are not any other packets such as ARP and replies.