Problem 1 : [7 points] In a protocol for maintaining global topology information, the processes p[i : 0..n-1] exchange messages of the form:

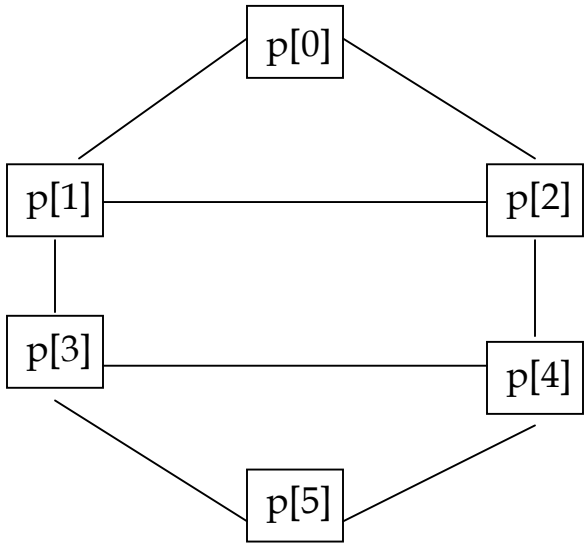
st(k, vp, r)

where k is the index of process p[k] that originally generated the message, vp is the local topology information of process p[k] when p[k] generated the message, and r is the number of remaining hops that the message can still make. For simplicity, assume that the exchanged messages in the protocol can be lost but neither corrupted nor reordered. A process in this protocol is specified as follows:

```
process p[i:0..n-1]

const   rmax

inp     N: set {g | p[g] is a neighbor of p[i]},
        up: array [N] of boolean

var     net  : array [0..n-1, 0..n-1] of boolean,
        vp   : array [0..n-1] of boolean,
        r    : 0..rmax-1,
        m    : 0..n,
        f,h  : N,
        k    : 0..n-1

par     g  : N

begin

        true                          --> S.0
[]      rcv st(k, vp, r) from p[g]    --> S.1

end
```

Specify statement S.1.

Problem 2 : [6 points] Assume that the protocol described in Problem 1 is to be deployed in a network whose topology is as follows:



What is a good value for rmax in this case? Explain your answer.

Problem 3 : [7 points] Two processes p and q circulate a chk(b) message in order to maintain their local topology information according to the protocol in Section 11.2. Each of the two processes has a boolean variable named "up" whose value is true when the two channels between p and q are both up. The two processes have different timeout actions. When p times out, it assigns the value false to its up variable and sends a chk(0) message to q. When q times out, it only assigns the value false to its up variable. Draw the state transition diagram for this protocol under the following assumptions:

i. Initially, the two up variables, namely up.p and up.q, have the value true, and the two channels, namely ch.p.q and ch.q.p, are empty.

ii. The channel ch.p.q is up and will stay up indefinitely, and the channel ch.q.p is down and will stay down indefinitely.

iii. Messages, that are sent to an up channel, are neither corrupted nor lost until they are received.
