1. Give the cycle structure representation for a 135 degree rotation of the corners of an 8-gon.

2. a) Construct the matching network and make a flow corresponding to the partial matching b-g, c-i, d-j, e-k.  
   b) Apply the Augmenting Flow Algorithm (show ALL labels) and from it obtain a 5-edge matching.

3. Consider the game of Nim on the right.
   a) What is the Grundy number of the initial position
      2
   b) Make a move to get into a kernel position using third pile.
      3
   c) Make a move to get into a position with Grundy number equal to 2
      7
   d) Suppose that 1 or 3 or 4 sticks can be removed at a time, determine the Grundy number of the initial condition and then make a move into the kernel.

4. Give an expression for the pattern inventory of 2-colorings of the edges of the unoriented figure on the right (rotations and flips allowed).

5. In the following table of remaining games, it is possible for the Bears to be champions or co-champions if they win all remaining games? Build the appropriate network model. Answer the question with an appropriate flow in the network you created or with an explanation of why one is not possible.

<table>
<thead>
<tr>
<th>Team</th>
<th>Wins</th>
<th>Games to date</th>
<th>with Bears</th>
<th>with Lions</th>
<th>with Tigers</th>
<th>with Vampires</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bears</td>
<td>19</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Lions</td>
<td>22</td>
<td>7</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Tigers</td>
<td>22</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Vampires</td>
<td>20</td>
<td>7</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

6. a) Find a Northwest corner solution to this Trans. Problem.  Warehouse 1 4 2 4 20
   b) Find a set of prices based on this initial solution.
   c) Find an entry, currently unused, whose use would lower the cost of the solution
      Demands 30 20 40
   d) Find a new spanning-tree solution using the edge found in c)