Part 1. Transportation Simplex Method.

Consider the feasible solution of the transportation problem below:

<table>
<thead>
<tr>
<th>dstn→</th>
<th>source</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>?</td>
<td>12</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>?</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>9</td>
<td>?</td>
<td>?</td>
<td>11</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>D</td>
<td>13</td>
<td>?</td>
<td>12</td>
<td>13</td>
<td>12</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>E</td>
<td>?</td>
<td>8</td>
<td>9</td>
<td>3</td>
<td>10</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>

Demand= 4 7 5 6 9

_1. Which additional variable (=0) of those below might be made a basic variable in order to complete the (degenerate) basis?
   a. XD1  
   b. XC3  
   c. XE1  
   d. XA1  
   e. XB2  
   f. None of above

_2. If we choose to assign dual variable UD=5, what must be the value of dual variable V3?
   a. 0  
   b. 6  
   c. 11  
   d. 3  
   e. 8  
   f. None of above

_3. If, in addition to UD=5, we determine that V2=−2, then the reduced cost of XD2 is
   a. 0  
   b. +5  
   c. +9  
   d. −3  
   e. −8  
   f. None of above

_4. If we initially assign UD=0 (rather than UD=5) and then compute the remaining dual variables, a different value of the reduced cost of XD2 will be obtained, although its sign will remain the same.
   a. True  
   b. False  
   c. Cannot be determined

_5. Suppose XE1 enters the basis (ignoring whether it would improve the solution or not). Which variable must leave the basis?
   a. XA2  
   b. XC4  
   c. XE3  
   d. XC1  
   e. XD3  
   f. None of above
Part 2: Assignment Problem

Consider the problem of assigning machines (rows) to jobs (columns), with cost matrix

\[
\begin{array}{cccccc}
1 & 2 & 3 & 4 & 5 \\
1 & 0 & 2 & 0 & 1 & 0 \\
2 & 2 & 2 & 0 & 6 & 3 \\
3 & 4 & 0 & 5 & 5 & 2 \\
4 & 7 & 0 & 5 & 3 & 4 \\
5 & 0 & 2 & 1 & 0 & 4 \\
\end{array}
\]

By drawing lines in rows 1&5 and in columns 2&3, all the **eight** zeroes are “covered”.

___ 1. After the next step of the Hungarian method, the number of zeroes in the cost matrix will be
   a. 7  
   b. 9  
   c. 11  
   d. 8  
   e. 10  
   f. None of the above

Consider the reduced assignment problem shown below:

\[
\begin{array}{cccccc}
1 & 2 & 3 & 4 & 5 \\
1 & 0 & 0 & 3 & 1 & 3 \\
2 & 1 & 2 & 0 & 2 & 0 \\
3 & 4 & 3 & 5 & 5 & 0 \\
4 & 1 & 0 & 5 & 3 & 5 \\
5 & 0 & 2 & 1 & 0 & 11 \\
\end{array}
\]

___ 2. A zero-cost solution of the problem with this cost matrix must have
   a. X_{11}=1  
   b. X_{12}=1  
   c. X_{54}=0  
   d. X_{42}=0  
   e. X_{25}=1  
   f. None of the above

Part 3. True(+) or False(o) ?

___ 1. The Hungarian algorithm can be used to solve a transportation problem.
___ 2. The number of basic variables in a n×n assignment problem is 2n.
___ 3. If the current basic solution of a transportation problem is degenerate, no improvement of the objective function will occur in the next iteration of the (transportation) simplex method.
___ 4. The Hungarian algorithm is the simplex method specialized to the assignment problem.
___ 5. At each iteration of the Hungarian method, the original cost matrix is replaced with a new cost matrix having the same optimal assignment.
___ 6. A “balanced” transportation problem has an equal number of supply and demand.