1.
(a) (10 marks)

<table>
<thead>
<tr>
<th></th>
<th>Alice</th>
<th>Bob</th>
<th>David</th>
<th>Cathy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alice</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Bob</td>
<td>3</td>
<td>0</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>David</td>
<td>4</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cathy</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

(b) (10 marks)

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<tbody>
<tr>
<td>Alice</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Bob</td>
<td>1</td>
<td>0</td>
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</tbody>
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2.
(a) (8 marks)
The eccentricity $\varepsilon$ of the vertex $v$ is the greatest distance (the distance means minimum distance here) between $v$ and any other vertex.
eccentricity (A) = max(AB,AD,AC)=max(3,2,1)=3
ref:
http://mathworld.wolfram.com/GraphDistance.html
(b) (6 marks)
The radius of a graph is the minimum eccentricity of any vertex.
eccentricity(A) = max(AB,AD,AC)=max(3,2,1)=3
eccentricity(B) = max(BA,BC,BD)=max(3,2,3)=3
eccentricity(C) = max(CA,CB,CD)=max(1,2,1)=2
eccentricity(D) = max(DA,DB,DC)=max(2,3,1)=3
radius = 2
(c) (6 marks)
The diameter of a graph is the maximum eccentricity of any vertex in the graph.
diameter = 3
3. (a) (10 marks)
   # of strongly connected components: 2
   1,2,3
   4,5,6
   (b) (10 marks)
   # of weakly connected components: 1
   1,2,3,4,5,6

4(a) (10 marks)
For undirected graphs, the graph density is:

\[ D = \frac{2|E|}{|V|(|V| - 1)} \]

density = \( \frac{2 \times 8}{5 \times (5 - 1)} = 0.8 \)

(b) (10 marks)
Let \( G = (V,E) \) with \( n \) vertices, the Degree centrality \( C_D(v) \) for a vertex \( v \) is defined as

\[ C_D(v) = \frac{\deg(v)}{n - 1} \]

\[ C_D(A) = \frac{3}{4} = 0.75 \]
\[ C_D(B) = \frac{3}{4} = 0.75 \]
\[ C_D(C) = \frac{4}{4} = 1 \]
\[ C_D(D) = \frac{3}{4} = 0.75 \]
\[ C_D(E) = \frac{3}{4} = 0.75 \]

5. (20 marks)
For undirected graphs, the graph density is:

\[ D = \frac{2|E|}{|V|(|V| - 1)} \]

Graph with 5 nodes, and 6 edges.