1. Each schema is a decomposition of \( R = (A, B, C, D, E, F) \). For each schema and set of functional dependencies, indicate the highest normal form of the schema and whether or not it is a lossless join and/or dependency preserving by placing an X in the appropriate blanks. You may assume the domain of each attribute is integer.

(a) \( F = \{AB \rightarrow CD, D \rightarrow EF, F \rightarrow A\}(ABCDEF) \)

\[
\begin{array}{cccccccc}
\text{1NF} & \text{3NF} & \text{BCNF} & \text{4NF} & \text{5NF} & \text{LJ} & \text{DP} \\
\end{array}
\]

(b) \( F = \{AB \rightarrow CD, D \rightarrow EF, F \rightarrow A\}(ABCD)(DEF)(AF) \)

\[
\begin{array}{cccccccc}
\text{1NF} & \text{3NF} & \text{BCNF} & \text{4NF} & \text{5NF} & \text{LJ} & \text{DP} \\
\end{array}
\]

(c) \( F = \{AB \rightarrow CD, D \rightarrow EF, F \rightarrow A\}(ABCDF)(ADE) \)

\[
\begin{array}{cccccccc}
\text{1NF} & \text{3NF} & \text{BCNF} & \text{4NF} & \text{5NF} & \text{LJ} & \text{DP} \\
\end{array}
\]

2. Decompose the relation \( R = (A, B, C, D, E, F) \) with the functional dependencies \( F = \{DE \rightarrow AF, A \rightarrow BC, C \rightarrow D\} \) into a BCNFLJ decomposition following the algorithm in the book.
3. For relation $R = (A, B, C, D, E, F)$ and functional dependencies $\mathcal{F} = \{DE \rightarrow AF, A \rightarrow BC, C \rightarrow D\}$ find all of the primary keys.

4. An SQL Injection attack (a) is only possible in web-database applications (b) requires detailed knowledge about the SQL statement (c) can be severely reduced or prevented by using prepared statements (d) all of the above (e) exactly two of the above (f) none of the above

5. Cross-site scripting (a) is only possible in web-database applications (b) requires detailed knowledge about the SQL statement (c) can be severely reduced or prevented by using prepared statements (d) all of the above (e) exactly two of the above (f) none of the above

6. An audit trail (a) is a log of all changes to the data (b) identifies who carried out each operation (c) aids in fixing damage caused by erroneous updates (d) all of the above (e) exactly two of the above (f) none of the above

7. Public key encryption (a) uses the same key to encrypt and decrypt data (b) is computationally faster than AES (c) requires a secure mechanism for key transmission (d) all of the above (e) exactly two of the above (f) none of the above

8. According to the textbook, SQL has a limited role in authorization because SQL (a) lacks end-user information (b) lacks fine grained authorization (c) lacks encryption capabilities (d) all of the above (e) exactly two of the above (f) none of the above
9. Describe each of the four parts of the simple DBMS architecture presented in class. (16) Explain each layer’s role in transaction processing.
10. What does the acronym ACID stand for? (4)

11. What does the acronym BASE stand for? (5)

12. Reproduce the CAP theorem. (5)

13. What is the input and output to a reducer in a Hadoop program? (5)

14. What data can be accessed by a vertex program in GraphLab? (5)
Table 1: Ratings for 4 users on 4 movies.

<table>
<thead>
<tr>
<th>User</th>
<th>Fellowship of the Ring</th>
<th>The Hobbit</th>
<th>Star Wars</th>
<th>Desolation of Smaug</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>B</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>1</td>
<td>⊥</td>
<td>1</td>
</tr>
<tr>
<td>Speegle</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>⊥</td>
</tr>
</tbody>
</table>

15. Given the Table 1, what are the best two possible predictions for how well I would like The Desolation of Smaug? Explain your answer and show your work!