Instructions:

- Read through the complete exam and note any unclear directives before you start solving the questions. The following guidelines hold:
  - Write clear and neat answers! Answers that cannot be read can obviously not result in any points and unclear formulations can be misunderstood.
  - Assumptions outside of what is stated in the question must be explained. Any assumptions made should not alter the given question.
  - Write your answer on only one side of the paper and use a new paper for each new question to simplify the correction process and to avoid possible misunderstandings.

- A passing grade requires about 50% of the maximum number of points.
1. **Database terminology:**

Explain the following database concepts:

(a) relational schema (sv. relationsschema)
(b) secondary index (sv. sekundärindex)
(c) deadlock (sv. "dödlig läsning")
(d) BCNF

2. **Data models:**

Explain the concepts primary key (sv. primäryckel) of the relational data model and object identifier (sv. objektidentifierare) of an object data model and their most important properties.

3. **Conceptual modeling:**

In enhanced entity-relationship modeling (sv. utökad entitets-relations-modellering) one can specify certain constraints for a specialization and generalization (sv. specialisering och generalisering). Explain in this context the following concepts:

(a) disjointness constraint
(b) completeness constraint

4. **Transactions:**

Describe the properties that one would like transactions to fulfill in a database context (hint: ACID).

5. **Physical database design:**

Explain the organization and functionality of hash-files (the answer should include how to retrieve a data record with regard to a specific search key of the hash-file).

6. **Object-oriented and object-relational databases:**

(a) Describe the three main kinds of user-definable database extensibility mechanisms available in an object-relational database system (sv. ’objektrelationell databas’)? (3pts)

(b) What is swizzling and what is it used for? (1pt)
7. Query optimization: 4 pts

(a) What is selectivity (sv. ’selektivitet’) and how is it used in a cost-based query optimizer? (1pt)

(b) What is the worst case complexity of cost-based query optimization? (1pt)

(c) Why does cost-based query optimization pay off despite its complexity? (1pt)

(d) How are operators in execution plans different from relational algebra operators? Give examples. (1pt)

8. Database APIs: 4 pts

(a) What is JDBC? (1 pt)

(b) How does JDBC handle the high cost of dynamic query optimization? (1 pt)

(c) What does ’O’ in ’ODBC’ stand for? (1 pt)

(d) How does JDBC handle queries that return very large result sets? (1 pt)

Good luck!

/ Kjell och Tore