

Answer any three out of the following five questions

1. Answer the following three parts.

a. What are the main reasons that the relational model has become so successful ?

[11 marks]

b. SQL by default does not remove duplicate rows. Discuss the main reason for this approach and illustrate your answer with an SQL query.

[11 marks]

c. Briefly discuss the differences between finding information in a relational database using SQL and finding information in the World-Wide-Web using a search engine.

[11 marks]

[Total 33 marks]

2. Answer the following three parts.

- a. What is the Universal Relation Schema Assumption (URSA) ? Discuss the importance of the URSA in the context of ISA relationships.

[11 marks]

- b. Why do multi-valued attributes in an Entity Relationship Diagram (ERD) violate First Normal Form ? Show with the aid of an ERD fragment how you would express a multi-valued attribute such as a set of authors using only single-valued attributes.

[11 marks]

- c. Write a sentence or two on each of the following:

1. physical data independence
2. growth independence
3. optional and mandatory classification of relationships
4. COMMIT and ROLLBACK
5. precision and recall

[11 marks]

[Total 33 marks]

3. Answer the following three parts.

- a. In the network and hierarchical data models records are linked together via pointers and querying the database is done via “pointer chasing”. How are entities related in the relational model ? Discuss the advantages of querying related entities in the relational model versus pointer chasing as a means of navigating through a database.

[11 marks]

- b. Express the natural join of two relations, one over a schema having attributes A and B and the other over a schema having attributes B and C, using the renaming, Cartesian product, selection and projection operators. Express this join query in SQL.

[11 marks]

- c. What are the two types of null value that are most common ? Give an example of how information can be lost when joining two relations having null values in the joined columns and suggest a solution.

[11 marks]

[Total 33 marks]

4. Answer the following three parts.

- a. Recall that the manipulative part for a *nested relational database* includes the two operators *NEST* and *UNNEST*. The operator *NEST* transforms a nested relation into a “more deeply” nested relation while the operator *UNNEST* transforms a nested relation into a “flatter” nested relation. Explain with the aid of an example how these operators are used, given that you have available a flat relational database.

[11 marks]

- b. In the presence of NULLs (interpreted as in SQL) we can redefine a functional dependency (FD)  $X \rightarrow Y$  to hold in a relation  $r$  over relation schema  $R$  if any two rows in  $r$  that do *not* have a NULL value in any attribute of  $X$  and, in addition, have the same  $X$ -values, also have the same  $Y$ -values. Is the transitivity inference rule sound for such FD with NULLs ?

[11 marks]

- c. Define Boyce-Codd Normal Form (BCNF) using an example. Why is BCNF sometimes referred to as the “ultimate normal form” in the presence of functional dependencies.

[11 marks]

[Total 33 marks]

5. Answer the following three parts.

- a. Give an efficient (i.e. polynomial time) algorithm for finding one key for a relation schema  $R$  with respect to a set of functional dependencies  $F$  over  $R$ .

[11 marks]

- b. Argue that if a relation schema  $R$  is in Third Normal Form but not in Boyce-Codd Normal Form with respect to a set of functional dependencies  $F$ , then it must have at least two distinct keys for  $R$  with respect to  $F$  which overlap, i.e. such that their intersection is nonempty.

[11 marks]

- c. Why do we need object-relational databases ?

[11 marks]

[Total 33 marks]

END OF PAPER