

1. What are the five major strengths of the relational model? List them and give a brief description of each. [10]
 2. (a) Let R & S be two relations with cardinality m & n respectively. They share a common column with x matching values. Write an expression for the no. of records in the following:
R (left outer join) S:
R (right outer join) S:
R (full outer join) S:
(b) An employee can work in several departments and can have many dependents. This information is being stored in a single relation. Somehow, you are not happy with the design. What is the current highest normal form of the relation? Identify the problems with the design and rectify them by suitably normalizing the relation to an appropriate normal form. [5+5]
 3. (a) A set of attributes X is called 'closed' wrt a set of FDs if $X^+ = X$. Consider a relation with schema $R(A,B,C,D)$ and an unknown set of FDs. Determine the set of FDs on R if all sets of attributes are closed.
(b) Prove that all 2-attribute relations are in BCNF. [5+5]
 4. Suppose that R is a relation with attributes A1, A2, ..., An. As a function of n, tell how many superkeys R has, if:
(a) The only key is A1
(b) The only keys are A1 & A2 [2.5+2.5]
 5. Give FDs for R (A, B, C, D) such that it is in 3NF, but not in BCNF [5]
 6. Given a relation R(A, B, C, D) and a set of FDs $F = \{A \rightarrow AC, B \rightarrow ABC, D \rightarrow ABC\}$. Find F_c . [10]
 7. Consider the following schema containing information about products that are there in a supermarket:
Prod_master(prod_key, prod_name, prod_description, sub_category, category, department)
There are 100,000 different products in the store. It is given that, on an average, there are 100 products in a subcategory, each category has 10 subcategories, and each department looks after 50 categories. Assume that all the subcategories, categories, and departments are distinct and a product can belong to only one subcategory, one category, and one department only.
(a) Write down all the FDs of the relation.
(b) Identify all the redundancies.
(c) Normalize the relation upto a suitable normal form, if needed.
(d) Calculate the space savings, if any, due to normalization. Assume that each attribute occupies 25 bytes of space. [2+2+3+3]
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- m
- n
- $m+n-x$

(1.5 marks each – all correct 5 marks)