Practice Exercises

8.1 Suppose that we decompose the schema $r(A, B, C, D, E)$ into

$$r_1(A, B, C)$$
$$r_2(A, D, E)$$

5

Show that this decomposition is a lossless decomposition if the following set F of functional dependencies holds:

$$A \rightarrow BC$$
$$CD \rightarrow E$$
$$B \rightarrow D$$
$$E \rightarrow A$$

8.3 Explain how functional dependencies can be used to indicate the following: 5

- A one-to-one relationship set exists between entity sets *student* and *instructor*.
- A many-to-one relationship set exists between entity sets *student* and *instructor*.

8.4 Use Armstrong's axioms to prove the soundness of the union rule. (*Hint*: Use the augmentation rule to show that, if $\alpha \rightarrow \beta$, then $\alpha \rightarrow \alpha\beta$. Apply the augmentation rule again, using $\alpha \rightarrow \gamma$, and then apply the transitivity rule.) 5

8.5 Use Armstrong's axioms to prove the soundness of the pseudotransitivity rule. 5

8.6 Compute the closure of the following set F of functional dependencies for relation schema r (A, B, C, D, E). 10

$$A \rightarrow BC$$
$$CD \rightarrow E$$
$$B \rightarrow D$$
$$E \rightarrow A$$

List the candidate keys for R.

8.7 Using the functional dependencies of Practice Exercise 8.6, compute the canonical cover F_c. 10

A	B	C
a_1	b_1	c_1
a_1	b_1	c_2
a_2	b_1	c_1
a_2	b_1	c_3

Figure 8.17 Relation of Practice Exercise 8.2.

8.9 Given the database schema $R(a, b, c)$, and a relation r on the schema R, write an SQL query to test whether the functional dependency $b \rightarrow c$ holds on relation r. Also write an SQL assertion that enforces the functional dependency; assume that no null values are present. (Although part of the SQL standard, such assertions are not supported by any database implementation currently.) 10

8.10 Our discussion of lossless-join decomposition implicitly assumed that attributes on the left-hand side of a functional dependency cannot take on null values. What could go wrong on decomposition, if this property is violated? 10

8.11 In the BCNF decomposition algorithm, suppose you use a functional dependency $\alpha \rightarrow \beta$ to decompose a relation schema $r(\alpha, \beta, \gamma)$ into $r_1(\alpha, \beta)$ and $r_2(\alpha, \gamma)$. 10

a. What primary and foreign-key constraint do you expect to hold on the decomposed relations?

b. Give an example of an inconsistency that can arise due to an erroneous update, if the foreign-key constraint were not enforced on the decomposed relations above.

c. When a relation is decomposed into 3NF using the algorithm in Section 8.5.2, what primary and foreign key dependencies would you expect will hold on the decomposed schema?

8.12 Let $R_1, R_2, \ldots, R_n$ be a decomposition of schema U. Let $u(U)$ be a relation, and let $r_i = \Pi_{R_i}(u)$. Show that 10

$$u \subseteq r_1 \bowtie r_2 \bowtie \cdots \bowtie r_n$$

8.14 Show that it is possible to ensure that a dependency-preserving decomposition into 3NF is a lossless decomposition by guaranteeing that at least one schema contains a candidate key for the schema being decomposed. (*Hint*: Show that the join of all the projections onto the schemas of the decomposition cannot have more tuples than the original relation.) 10

8.16 Let a **prime** attribute be one that appears in at least one candidate key. Let α and β be sets of attributes such that $\alpha \rightarrow \beta$ holds, but $\beta \rightarrow \alpha$ does not hold. Let A be an attribute that is not in α, is not in β, and for which $\beta \rightarrow A$ holds. We say that A is **transitively dependent** on α. We can restate our definition of 3NF as follows: *A relation schema R is in 3NF with respect to a set F of functional dependencies if there are no nonprime attributes A in R for which A is transitively dependent on a key for R.* Show that this new definition is equivalent to the original one. 10

8.17 A functional dependency $\alpha \rightarrow \beta$ is called a **partial dependency** if there is a proper subset γ of α such that $\gamma \rightarrow \beta$. We say that β is *partially dependent* on α. A relation schema R is in **second normal form** (2NF) if each attribute A in R meets one of the following criteria: 10

- It appears in a candidate key.
- It is not partially dependent on a candidate key.

Show that every 3NF schema is in 2NF. (*Hint*: Show that every partial dependency is a transitive dependency.)

8.18 Give an example of a relation schema R and a set of dependencies such that R is in BCNF but is not in 4NF. 10

Exercises

8.21 Normalize the following schema, with given constraints, to 4NF. 10

books(*accessionno*, *isbn*, *title*, *author*, *publisher*)
users(*userid*, *name*, *deptid*, *deptname*)
accessionno $\rightarrow$ *isbn*
isbn $\rightarrow$ *title*
isbn $\rightarrow$ *publisher*
isbn $\rightarrow\!\!\!\rightarrow$ *author*
userid $\rightarrow$ *name*
userid $\rightarrow$ *deptid*
deptid $\rightarrow$ *deptname*

8.22 Explain what is meant by *repetition of information* and *inability to represent information*. Explain why each of these properties may indicate a bad relational database design. 10

8.23 Why are certain functional dependencies called *trivial* functional dependencies? 10

8.24 Use the definition of functional dependency to argue that each of Armstrong's axioms (reflexivity, augmentation, and transitivity) is sound. 5

8.25 Consider the following proposed rule for functional dependencies: If $\alpha \rightarrow \beta$ and $\gamma \rightarrow \beta$, then $\alpha \rightarrow \gamma$. Prove that this rule is *not* sound by showing a relation r that satisfies $\alpha \rightarrow \beta$ and $\gamma \rightarrow \beta$, but does not satisfy $\alpha \rightarrow \gamma$. 5

8.26 Use Armstrong's axioms to prove the soundness of the decomposition rule. 5

8.29 Consider the following set F of functional dependencies on the relation schema $r(A, B, C, D, E, F)$: 10

$$A \rightarrow BCD$$
$$BC \rightarrow DE$$
$$B \rightarrow D$$
$$D \rightarrow A$$

a. Compute B^+.

b. Prove (using Armstrong's axioms) that AF is a superkey.

c. Compute a canonical cover for the above set of functional dependencies F; give each step of your derivation with an explanation.

d. Give a 3NF decomposition of r based on the canonical cover.

e. Give a BCNF decomposition of r using the original set of functional dependencies.

f. Can you get the same BCNF decomposition of r as above, using the canonical cover?

8.30 List the three design goals for relational databases, and explain why each is desirable. 5

8.31 In designing a relational database, why might we choose a non-BCNF design? 5

8.33 Given a relational schema $r(A, B, C, D)$, does $A \twoheadrightarrow BC$ logically imply $A \twoheadrightarrow B$ and $A \twoheadrightarrow C$? If yes prove it, else give a counter example. 5

8.34 Explain why 4NF is a normal form more desirable than BCNF. 10

QUESTIONS FROM STUDY MATERIALS

Module 3

Define redundancy?	2
Define functional dependency?	2
Discuss normalization?	2
Illustrate functional dependency with example?	2
Illustrate fully functional dependency with example?	2
Demonstrate transitive dependency? Give an example?	2
Discuss Domain-Key Normal Form?	2
Define Armstrong axioms for FD's?	2
Define First Normal Form?	2
Define second Normal Form?	2
Define third Normal Form?	2
Define Fourth Normal Form?	2
List out the Problems related to decompositions?	2
Explain about Loss less-join dependency?	2
Explain about BCNF?	2

Explain about multi-valued dependencies?	2
Define join dependency and fifth normal form?	2
Explain the concept scheme refinement in database design?	2
Define dependency preserving decomposition?	2
Explain about inclusion dependency?	2
Define schema?	2
Define the terms Entity type	2
Define strong entity sets?	2
Explain about stored attributes?	2
Define a Transaction?	2
Define normalization? Explain 1NF, 2NF, 3NF Normal forms?	5
Compare and contrast BCNF with 3NF?	5
Describe properties of decompositions?	5
Explain about Schema refinement in Database design?	5
Illustrate Multivalued dependencies and Fourth normal form with example?	5

example?	
Discuss about Join dependencies and Fifth normal form?	5
Illustrate Inclusion dependencies with example?	5
Explain Atomicity	5
Discuss How do you implement Durability?	5
Discuss How do you implement Atomicity ?	5
Discuss Serializability in detail?	5
Explain Durability	5
Explain consistancy	5
Explain Isolation	5
Discuss in detail Multiple Granularity?	5
Given a relation R(A, B, C, D) and Functional Dependency set FD = { AB → CD, B → C }, determine whether the given R is in 2NF? If not convert it into 2 NF.	10
Given a relation R(X, Y, Z, W, P) and Functional Dependency set FD = { X → Y, Y → P, and Z → W}, determine whether the given R is in 3NF? If not convert it into 3 NF.	10
Given a relational schema R(X, Y, Z) set of functional dependencies P and Q such that: P = { X → Y, Y → Z, Z → X } and Q = { X → YZ, Y → X, Z → X } using FD sets P and Q proof that P=Q	10
Discuss about Lossless Decomposition with example	10
Discuss about Dependency Perverse with example	10
Discuss Multivalued dependency with example	10

Discuss Join dependency with example	10
Discuss Inclusion dependence with example	10
Given a relational Schema R(V, W, X, Y, Z) and set of Function Dependency FD = { V → W, VW → X, Y → VXZ }. Find the canonical cover?	10
Discuss Reflexsive, augmentation and transitive rule	10
Discuss 4NF and 5NF normalization with example	10
Discuss 2NF and 3NF normalization with example	10
Discuss the different type of normal form and their description	10
Discuss the advantage and disadvantage of normaliztion	10
Discuss Insertion anomaly	2
Show that: if α → β and α → γ then α → βγ	10
Consider the following relational schemes for a library database: Book (Title, Author, Catalog_no, Publisher, Year, Price) Collection (Title, Author, Catalog_no) the following are functional dependencies: a. Title Author --> Catalog_no b. Catalog_no --> Title Author Publisher Year c. Publisher Title Year --> Price d. Assume {Author, Title} is the key for both schemes. Apply the appropriate normal form for Book and Cancellation?	10
Consider a schema R (A, B, C, D) and functional dependencies A -> B and C ->D. Solve and find whether the decomposition of R into R1 (A, B) and R2(C, D) belongs to which one or both (dependency preserving and loss less join)?	10