A close-up of a document

Description automatically generated

Question 1

1. Table is in 1NF

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Employees | |  | Projects | | |
| EmployeeID | EmployeeName |  | ProjectID | ProjectName | ProjectDepartment |
| E01 | “John Doe” |  | P01 | “Project Alpha” | “IT” |
| E02 | “Jane Smith” |  | P02 | “Project Beta” | “Marketing” |
| E03 | “Mike Brown” |  | P03 | “Project Gamma” | “Development” |
|  |  |  |  |  |  |
| EmployeeProjects | |  |  |  |  |
| EmployeeID | ProjectID |  |  |  |  |
| E01 | P01 |  |  |  |  |
| E01 | P03 |  |  |  |  |
| E02 | P02 |  |  |  |  |
| E03 | P02 |  |  |  |  |

1. Table is in 2NF

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| BookPurchases | |  | Books | | | |
| Purchase ID | Book ID |  | BookID | Book Title | Author Name | Release Date |
| 001 | B01 |  | B01 | “The Great Gatsby” | “F. Scott Fitzgerald” | 1925 |
| 002 | B02 |  | B02 | “To Kill a Mockingbird” | “Harper Lee” | 1960 |
| 003 | B01 |  | B03 | “1984” | “George Orwell” | 1949 |
| 004 | B03 |  |  |  |  |  |

1. Table is not normalized

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| CollectionBooks | | | | |
| Book | Author | Price | Publisher | Year |
| “Book A” | “Author X” | 20 | “Publisher Z” | 2020 |
| “Book A” | “Author Y” | 20 | “Publisher Z” | 2020 |
| “Book B” | “Author X” | 15 | “Publisher Y” | 2022 |
| “Book B” | “Author Z” | 15 | “Publisher Y” | 2022 |
| “Book C” | “Author Y” | 25 | “Publisher Z” | 2019 |
| “Book C” | “Author Z” | 25 | “Publisher Z” | 2019 |

Question 2  
A) R is in 1NF as it has partial dependencies. New tables:  
 R0(A, C), S0 = {A->C}  
 R1(B, D), S1 = {B->D}  
 R2(A, B)

B) R is in 2NF but not 3NF as transitive dependencies. New Tables:  
 R0(A, B, C, E), S0 = {A->B, AB->C, A->E}  
 R1(C, D), S1 = {C->D}

C) R is in 2NF and 3NF, but not in BCNF.

D) New tables:  
 R0(ABCE), S0 = {AB->CE, C->ABE}  
 R1(DE), S1 = {E->D}

Question3  
A) Lossy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| A | B | C | D | E | F |
| a | b | c1 | d1 | e | f1 |
| a2 | b | c2 | d | e | f2 |
| a3 | b3 | c | d3 | e | f |
| a4 | b4 | c | d | e4 | f |
| C->E | | | | | |
| A | B | C | D | E | F |
| a | b | c1 | d1 | e | f1 |
| a2 | b | c2 | d | e | f2 |
| a3 | b3 | c | d3 | e | f |
| a4 | b4 | c | d | e | f |
| CF->D | | | | | |
| A | B | C | D | E | F |
| a | b | c1 | d1 | e | f1 |
| a2 | b | c2 | d | e | f2 |
| a3 | b3 | c | d | e | f |
| a4 | b4 | c | d | e | f |
| EC->A | | | | | |
| A | B | C | D | E | F |
| a | b | c1 | d1 | e | f1 |
| a2 | b | c2 | d | e | f2 |
| a3 | b3 | c | d | e | f |
| a3 | b4 | c | d | e | f |
| A->B | | | | | |
| A | B | C | D | E | F |
| a | b | c1 | d1 | e | f1 |
| a2 | b | c2 | d | e | f2 |
| a3 | b3 | c | d | e | f |
| a3 | b3 | c | d | e | f |

B) Lossless  
R1 ∩ R2 = CF  
CF forms a super key.

C) Not dependency preserving, breaks down on EC->A

Question 4  
A)   
Step 1, minimal cover:  
 AD->E  
 B->CD  
 DE->AB  
Step 2, Convert to relational schemas:  
 R0(ADE)  
 R1(BCD)  
 R2(DEAB)  
Step 3, Check if candidate key is contained in a relation:  
 Candidate key DE contained in R2  
Step 4, Test for containment:  
 R0 is contained in R1+R2  
Step 5, return  
 R0(BCD)  
 R1(DEAB)

B)  
R vs Ri: R is the original relationship schema, and each Ri contains a subset of the attributes in R, while ensuring that no transitive dependencies exist within any of the Ri’s. Collectively, the Ri’s represent the decomposed form of R.  
F vs Fi: F is the complete set of functional dependencies present in the relational schema R, and each Fi represents the subset of functional dependencies that only involve the attributes present in the corresponding Ri.

C) The new schema in (a) is in BCNF. Both of the relations and their functional dependencies in (a) are in BCNF as there are no transient dependencies. Because both relations are in BCNF, the relational schema as a whole is in BCNF.

D)   
First FD violation: B->CD  
Decompose: R1(BCD); R2(ABE)  
F1 = B->CD  
F2 = Empty set

Next iteration:  
R1 is BCNF  
R2 has no FD’s and is therefore BCNF

Final schema:  
R1(BCD)  
R2(ABE)

E)  
R vs Ri: R is the original relationship schema, and each Ri contains a subset of the attributes in R, while ensuring that no transitive dependencies exist within any of the Ri’s. Collectively, the Ri’s represent the leaf nodes of the recursion tree which represents the decomposed form of R.  
F vs Fi: F is the complete set of functional dependencies present in the relational schema R, and each Fi represents the subset of functional dependencies that only involve the attributes present in the corresponding Ri.

Question 5

A) In Department table: foreign key (managerID) references Employee(eID)

B)   
CREATE TABLE EmployeeProjectsCount (  
 pID int not null,  
 numOfEmployees int not null,  
 primary key (pID)  
 CHECK(numOfEmployees >= 0);

C)   
CREATE OR REPLACE TRIGGER trg\_after\_employee\_project\_delete  
AFTER DELETE ON EmployeeProject  
FOR EACH ROW  
BEGIN

-- Decrement numOfEmployees  
 UPDATE EmployeeProjectsCount  
 SET numOfEmployees = numOfEmployees – 1  
 WHERE pID = :OLD.pID;

-- Check if numOfEmployees is now 0  
 DECLARE  
 remaining\_employees NUMBER;  
 BEGIN  
 SELECT numOfEmployees  
 INTO remaining\_employees  
 FROM EmployeeProjectsCount  
 WHERE pID = :OLD.pID;

-- If numOfEmployees is 0, update endDate  
 IF remaining\_employees = 0 THEN  
 UPDATE Project  
 SET endDate = SYSDATE  
 WHERE pID = :OLD.pID;  
 END IF;  
 END;  
END;