Activity (Slow Learner) – With Solution

Context

You have the following unnormalized table representing a student enrollment system:

Student_Course(Student_ID, Student_Name, Course_ID, Course_Name, Instructor, Instructor_Office)

Task

Normalize the given table step-by-step through 1NF, 2NF, 3NF, and BCNF. Clearly explain and identify each step, functional dependencies, and transitive dependencies explicitly.

Detailed Solution

Detailed Step 1: Identify Anomalies in Unnormalized Relation

• Insertion Anomaly: You can't add an instructor's details unless you also add a student enrolled in their course.
• Deletion Anomaly: Removing a student's enrollment might accidentally remove important instructor information.
• Update Anomaly: If an instructor's office changes, it must be updated in every row, causing potential inconsistency.

Detailed Step 2: First Normal Form (1NF)

• Definition: No repeating groups or arrays.
• Current Status: Already in 1NF as each cell contains atomic values.

Detailed Step 3: Second Normal Form (2NF)

• Definition: 1NF + no partial dependencies (attributes depending only on a part of the composite key).
• Partial Dependencies identified:
  - Student_ID → Student_Name (student attributes depend only on Student_ID)
  - Course_ID → Course_Name, Instructor, Instructor_Office (course attributes depend only on Course_ID)
• Tables after resolving 2NF:
  - Students(Student_ID, Student_Name)
  - Courses(Course_ID, Course_Name, Instructor, Instructor_Office)
  - Enrollment(Student_ID, Course_ID)

Detailed Step 4: Third Normal Form (3NF)

• Definition: 2NF + no transitive dependencies (non-key attributes depend only on the primary key).
• Transitive Dependency identified:
  - Course_ID → Instructor → Instructor_Office

• Split tables to remove transitive dependency:
- Courses(Course_ID, Course_Name, Instructor)
- Instructors(Instructor, Instructor_Office)

Detailed Step 5: Boyce-Codd Normal Form (BCNF)
• Definition: 3NF + every determinant must be a candidate key.
• Checking BCNF compliance:
- Each determinant in Students, Courses, Enrollment, and Instructors is now a candidate key.
• All tables satisfy BCNF.

Final Set of Tables (Fully Normalized):
• Students(Student_ID, Student_Name)
• Courses(Course_ID, Course_Name, Instructor)
• Enrollment(Student_ID, Course_ID)
• Instructors(Instructor, Instructor_Office)

Task 2: Analyze the Normal Form of a New Relation

Task 6: You are given a new relation with the following attributes and dependencies. Determine the highest normal form (1NF, 2NF, 3NF, BCNF) that it satisfies, and explain your reasoning step by step.

Relation: Department_Employee(Emp_ID, Emp_Name, Dept_ID, Dept_Name, Dept_Location)
Functional Dependencies:
- Emp_ID → Emp_Name, Dept_ID
- Dept_ID → Dept_Name, Dept_Location

Detailed Solution for Task 2

Step 1: First Normal Form (1NF)
• All attributes are atomic (not multivalued or nested), so the relation is in 1NF.
Step 2: Second Normal Form (2NF)
• The primary key appears to be Emp_ID (assuming one department per employee).
• All non-key attributes are fully dependent on Emp_ID.
• Thus, the relation is in 2NF.
Step 3: Third Normal Form (3NF)
• Identify transitive dependencies:
- Emp_ID → Dept_ID
- Dept_ID → Dept_Name, Dept_Location
- Therefore, Emp_ID → Dept_ID → Dept_Name, Dept_Location (transitive

dependency)
• Since Dept_Name and Dept_Location are transitively dependent on Emp_ID, this violates 3NF.
Step 4: Resolve for 3NF
• Break into two relations:
- Employee(Emp_ID, Emp_Name, Dept_ID)
- Department(Dept_ID, Dept_Name, Dept_Location)
Step 5: BCNF
• Now, in both relations, the only determinants are candidate keys.
• Hence, both relations satisfy BCNF.
Final Tables:
• Employee(Emp_ID, Emp_Name, Dept_ID)
• Department(Dept_ID, Dept_Name, Dept_Location)

Task 3:

Question:
From the following data, identify any functional dependencies:

EmpID	EmpName	DeptID	DeptName
101	Alice	D1	Sales
102	Bob	D2	HR
103	Charlie	D1	Sales

Answer:

- EmpID → EmpName
- DeptID → DeptName

Task 4: Identify Partial Dependencies

Question:
Given relation R(StudentID, CourseID, Grade) with composite key (StudentID, CourseID), identify partial dependencies if Grade depends only on CourseID.
Answer:

- Grade depends only on CourseID, part of the composite key → partial dependency.

Task 5: Normalize to 2NF

Question:
Normalize the table R(StudentID, CourseID, Grade) with partial dependency Grade → CourseID to 2NF.
Answer:

- Split into:
  - R1(StudentID, CourseID)
  - R2(CourseID, Grade)