**Project Part 3**

***Question 2***

Normalize the following initial design to 3NF then draw the E.R model of the final design (hint : you will have 5 entities at the end of the process) :

FACULTY(FID, FName, Salary)

COURSE\_SECTION(CourseNo, CourseName, Section-ID, FID, FName, (Student-ID, StudentName, GRADE))

The initial design above, FACULTY, is in 1FN.

The initial design above, COURSE\_SECTION, is not in 1FN because there is a repeating group of columns which are Student-ID, StudentName and GRADE.

1. 1st Normal Form

These following rules must be respected for the table to be in 1FN :

* Each column of the table must be single-valued.
* Each column should have a unique name.
* A column should contain the same type of values.
* The order of the data stored does not matter.

FACULTY

|  |  |  |
| --- | --- | --- |
| FID | FName | Salary |
| 4626 | Design and Computation Arts | 250000 |
| 4559 | Music | 200000 |
| 4262 | Studio Arts | 200000 |

The primary key is FID because it is unique, not null and minimal.

COURSE\_SECTION1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| CourseNo | CourseName | Section-ID | FID | FName | Student-ID | StudentName | GRADE |
| 001 | C# | 101 | 4626 | Design and Computation Arts | 20201 | Shin | A |
| 002 | Painting | 202 | 4262 | Studio Arts | 20202 | Ryu | A |
| 003 | Composition | 303 | 4559 | Music | 20201 | Shin | B |
| 003 | Composition | 302 | 4559 | Music | 20203 | Zen | A |

The primary key is a composite key of Section-ID and Student-ID because they are in a many-to-many relationship : a course section (a course can have more than one section of the same type) can be opted by more than one student, and a student can opt for more than one course section.

Now we have the following design in 1FN :

FACULTY(FID, FName, Salary)

COURSE\_SECTION1 (CourseNo, CourseName, Section-ID, FID, FName, Student-ID, StudentName, GRADE)

The design above, COURSE\_SECTION1, is not in 2FN because there are partial dependencies.

1. 2nd Normal Form

These following rules must be respected for the table to be in 2FN :

* The table should be in 1st Normal Form.
* The table should not have any partial dependencies.

By observing the table COURSE\_SECTION1, we notice five partial dependencies :

* The CourseNo, CourseName, FID and FName only depends on Section-ID and not necessarily on Student-ID.
* The StudentName only depends on Student-ID and not necessarily on Section-ID.

GRADE is functionally dependent on the whole primary key (Section-ID + Student-ID). It is impossible to find a specific GRADE record with Section-ID only or with Student-ID only in this case, which means GRADE is not a partial dependency.

We are to divide the table COURSE\_SECTION1 in 3 new tables to remove the partial dependencies :

* CourseSection2 (Section-ID, CourseNo, CourseName, FID, FName)
* Student2 (Student-ID, StudentName)
* Grade2 (Section-ID, Student-ID, GRADE)

Grade2 Student2

|  |  |  |
| --- | --- | --- |
| Section-ID | Student-ID | GRADE |
| 101 | 20201 | A |
| 202 | 20202 | A |
| 303 | 20201 | B |
| 302 | 20203 | A |

|  |  |
| --- | --- |
| Student-ID | StudentName |
| 20201 | Shin |
| 20202 | Ryu |
| 20203 | Zen |

CourseSection2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| CourseNo | CourseName | Section-ID | FID | FName |
| 001 | C# | 101 | 4626 | Design and Computation Arts |
| 002 | Painting | 202 | 4262 | Studio Arts |
| 003 | Composition | 303 | 4559 | Music |
| 003 | Composition | 302 | 4559 | Music |

PK in CourseSection2 = Section-ID

PK in Student2 = Student-ID

PK in Grade2 = Section-ID + Student-ID (composite key)

FK1 in Grade2 = Section-ID

FK2 in Grade2 = Student-ID

The following design is not in 3FN because there is a transitive dependency :

FACULTY(FID, FName, Salary)

CourseSection2 (Section-ID, CourseNo, CourseName, FID, FName)

Student2 (Student-ID, StudentName)

Grade2 (Section-ID, Student-ID, GRADE)

1. 3rd Normal Form

These following rules must be respected for the table to be in 3FN :

* The table should be in 2nd Normal Form.
* The table should not have any transitive dependencies.

By observing the table CourseSection2, we notice two transitive dependency :

* The CourseName only depends on CourseNo and not necessarily on the primary key of Section-ID. CourseNo is not part of the primary key in the table CourseSection2.
* The FName only depends on FID and not necessarily on the primary key of Section-ID. FID is not part of the primary key in the table CourseSection2.

We are to divide the table CourseSection2 in three tables which results to this following design to remove the transitive dependency :

* CourseSection3 (Section-ID, CourseNo, FID)
* Course3 (CourseNo, CourseName)
* FACULTY(FID, FName, Salary)
* Student2 (Student-ID, StudentName)
* Grade2 (Section-ID, Student-ID, GRADE)

Note : There should have been a table Faculty3 with the columns FID and FName (Faculty3 (FID, FName)) instead of FACULTY(FID, FName, Salary). We notice there is a redundancy of attributes between the supposed Faculty3 (FID, FName) and FACULTY(FID, FName, Salary). To remove this redundancy of attributes, we are prioritizing the entity that presents the most details (attributes). Therefore, Faculty3 (FID, FName) has been replaced by FACULTY(FID, FName, Salary).

Grade2 Student2

|  |  |  |
| --- | --- | --- |
| Section-ID | Student-ID | GRADE |
| 101 | 20201 | A |
| 202 | 20202 | A |
| 303 | 20201 | B |
| 302 | 20203 | A |

|  |  |
| --- | --- |
| Student-ID | StudentName |
| 20201 | Shin |
| 20202 | Ryu |
| 20203 | Zen |

Course3 CourseSection3

|  |  |
| --- | --- |
| CourseNo | CourseName |
| 001 | C# |
| 002 | Painting |
| 003 | Composition |

|  |  |  |
| --- | --- | --- |
| CourseNo | Section-ID | FID |
| 001 | 101 | 4626 |
| 002 | 202 | 4262 |
| 003 | 303 | 4559 |
| 003 | 302 | 4559 |

|  |  |  |
| --- | --- | --- |
| FID | FName | Salary |
| 4626 | Design and Computation Arts | 250000 |
| 4559 | Music | 200000 |
| 4262 | Studio Arts | 200000 |

FACULTY

PK in FACULTY = FID

PK in Course3 = CourseNo

PK in CourseSection3 = Section-ID

FK1 in CourseSection3 = CourseNo

FK2 in CourseSection3 = FID

PK in Student2 = Student-ID

PK in Grade2 = Section-ID + Student-ID (composite key)

FK1 in Grade2 = Section-ID

FK2 in Grade2 = Student-ID