UCS1412 Database Lab
Assignment 9

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A Database Design Using Normal Forms

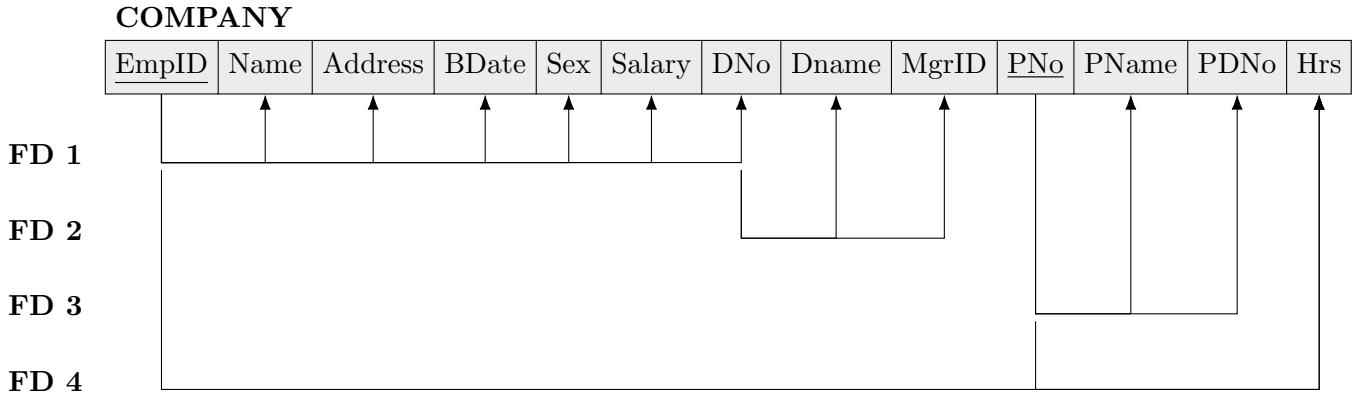

Figure 1: Company Relation

A.1 Identifying Primary Key

Proof. Let K be set of attributes which form the primary key and R be the set of of attributes in the **COMPANY** relation.

$K := R$
$A := \{Name, Address, BDate, Sex, Salary, DName, MgrID, PName, PDNo, Hrs\}$
$(K - A)^+ := R$ (Directly inferred from FDs)
$\therefore K := K - A$

$Now, K = \{EmpID, DNo, PNo\}$
Dno can be removed from K as $EmpID \rightarrow DNo$ (From FD1)
$\therefore K = \{EmpID, PNo\}$
$(EmpID, PNo)^+ = \{Name, Address, BDate, Sex, Salary, DNo, DName, MgrID, PName, PDNo, Hrs\}$
$i.e\ K^+ = R$
$(EmpID)^+ = \{Name, Address, BDate, Sex, Salary, DNo, DName, MgrID\}$
$(PNo)^+ = \{PName, PDNo\}$
Since neither attribute's closure with respect to the given set of FDs can fully determine all attributes, neither of them can be removed.
$\therefore K$ represents the primary key of COMPANY
$\therefore$ **Primary Key = {*EmpID,PNo*}**

□

A.2 1st Normal Form

The relation does not contain any multivalued attributes or nested relations and hence is in 1NF.

A.3 2nd Normal Form

Functional Dependencies 1 and 3 are only partial dependencies. Hence the relation is not in 2NF. Therefore the relation is decomposed into 3 sub-relations.

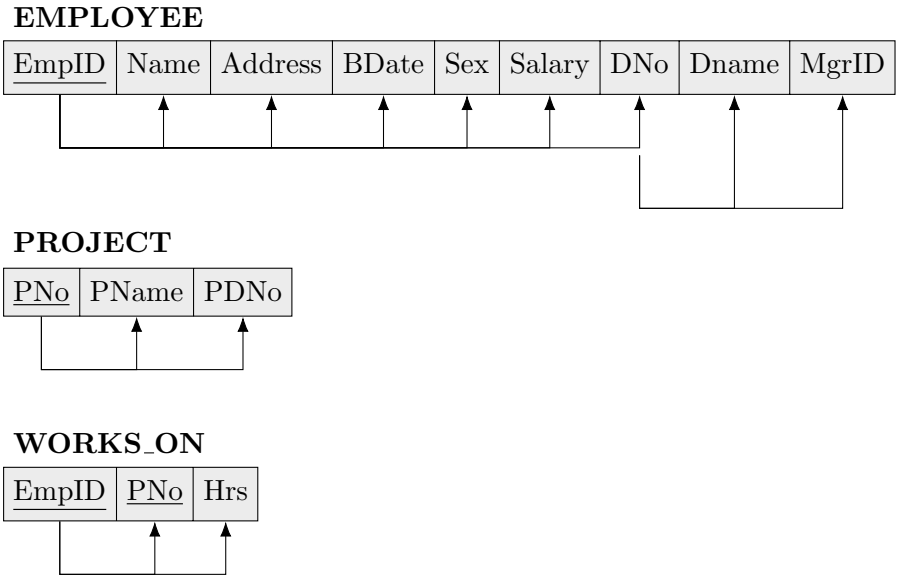

Figure 2: Decomposition after 2NF

A.4 3rd Normal Form

Functional Dependencies 1 and 2 are transitive and hence the table is not in 3NF. Therefore the **EMPLOYEE** relation is further decomposed into 2 sub-relations.

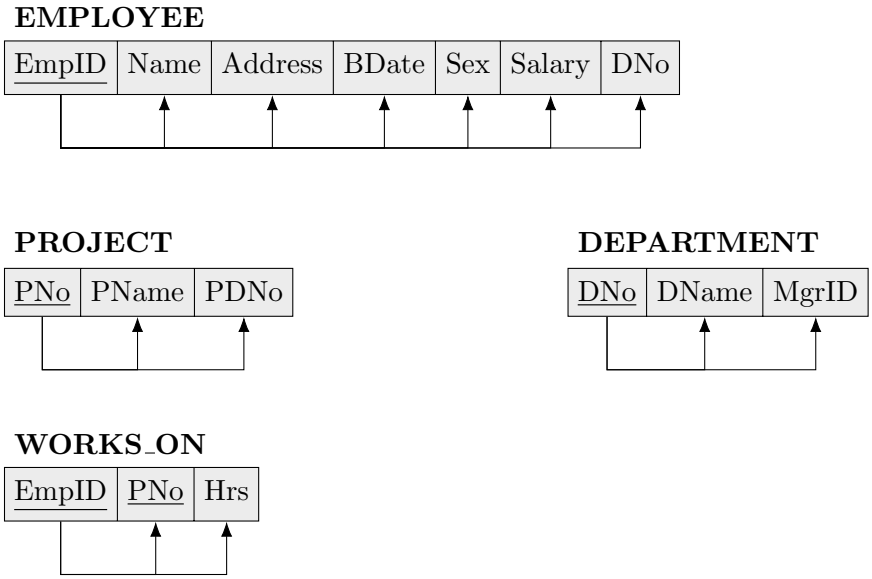

Figure 3: Decomposition after 3NF

A.5 Boyce Codd Normal Form

Since all functional dependencies are dependent on Superkeys, the relation is in BCNF.

A.6 Verifying Normalization

A.6.1 Preservation of Functional Dependencies

- **FD1** has been preserved in the **EMPLOYEE** relation
- **FD2** has been preserved in the **DEPARTMENT** relation
- **FD3** has been preserved in the **PROJECT** relation
- **FD4** has been preserved in the **WORKS_ON** relation

$\therefore$ All **4** functional dependencies have been preserved after normalization.

A.6.2 Lossless Join

B Database Design Using ER Diagram

B.1 ER Diagram From Requirements

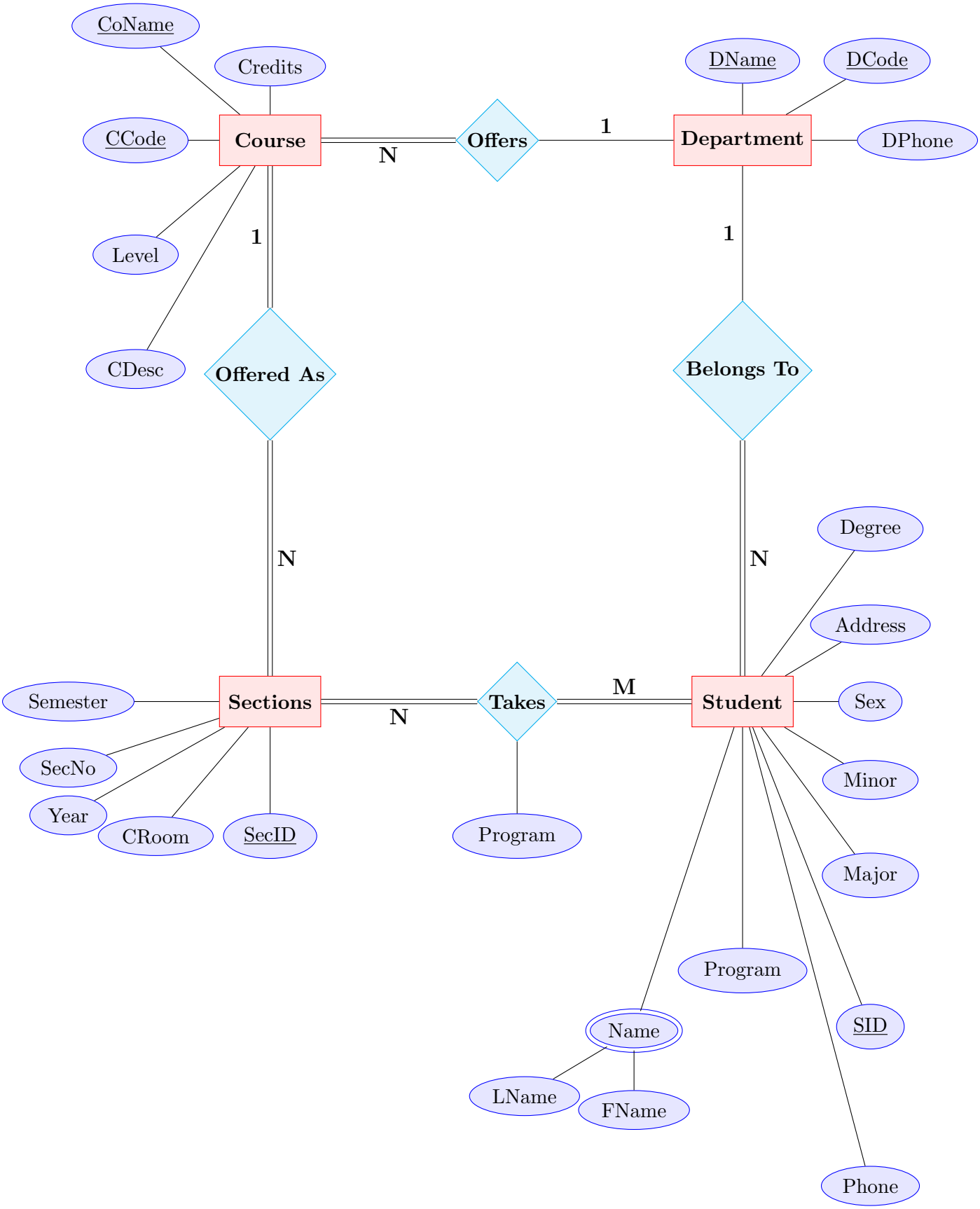

Figure 4: ER Diagram

B.2 ER Relational Mapping

The following was done to convert the ER Diagram (Figure 4) to the Relational Model.

1. Each entity was made into a relation with all of its given attributes.
2. To represent the **Offered As** $(1 : N)$ relationship, an attribute is added to the Section relation which references CCode, the primary key of the Course relation.
3. To represent the **Offers** $(1 : N)$ relationship, an attribute is added to the Course relation which references DCode, the primary key of the Department relation.
4. To represent the **Belongs To** $(1 : N)$ relationship, an attribute is added to the Student relation which references DCode, the primary key of the Department relation.
5. To represent the **Takes** $(M : N)$ relationship, a new relation Takes which contains the grade attribute of the reltionship as well as the primary keys of the participating realtions (SecID,SID) is created.

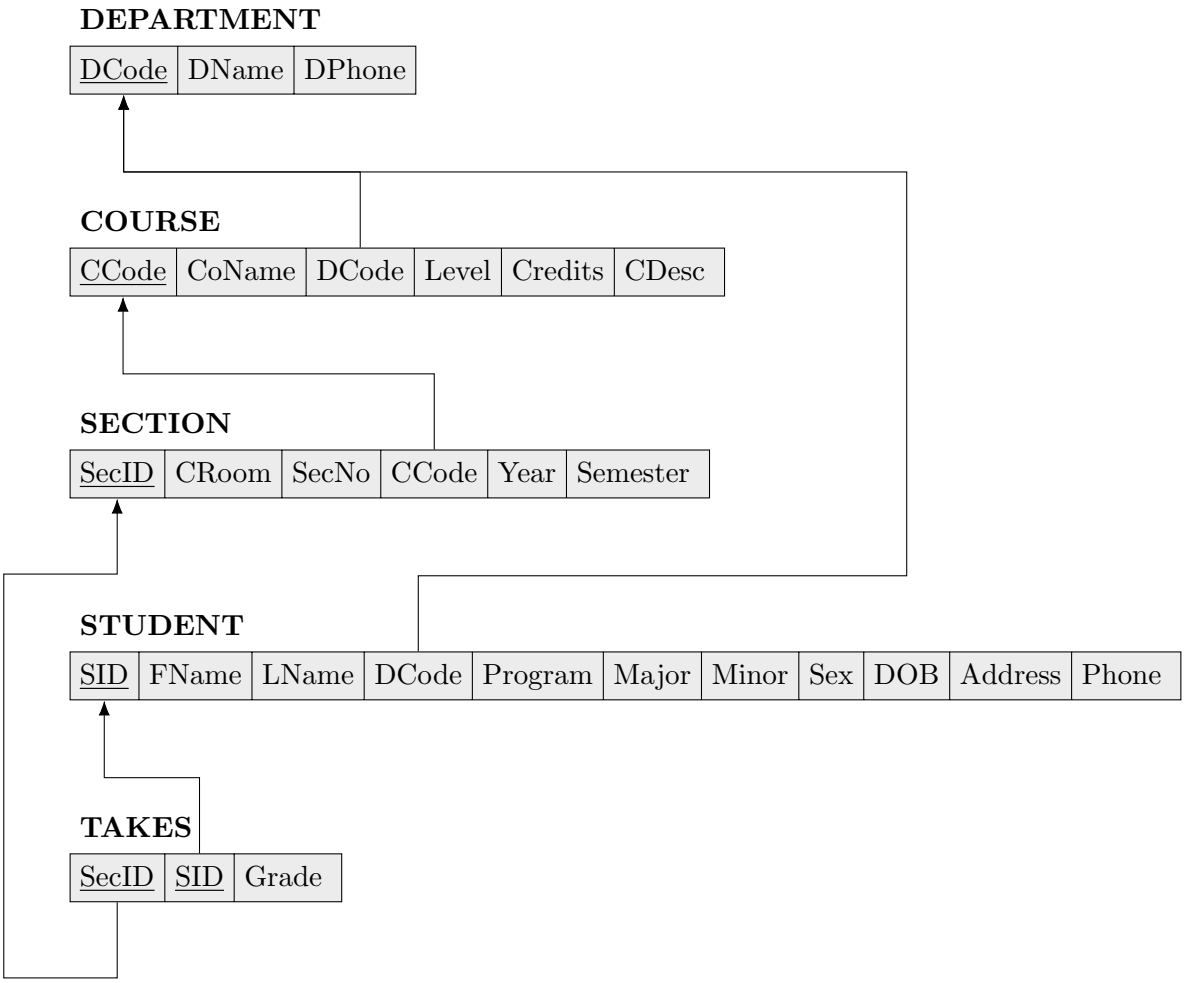

Figure 5: Schema Diagram