UCS1412 Database Lab
Assignment 9

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A Database Design Using Normal Forms

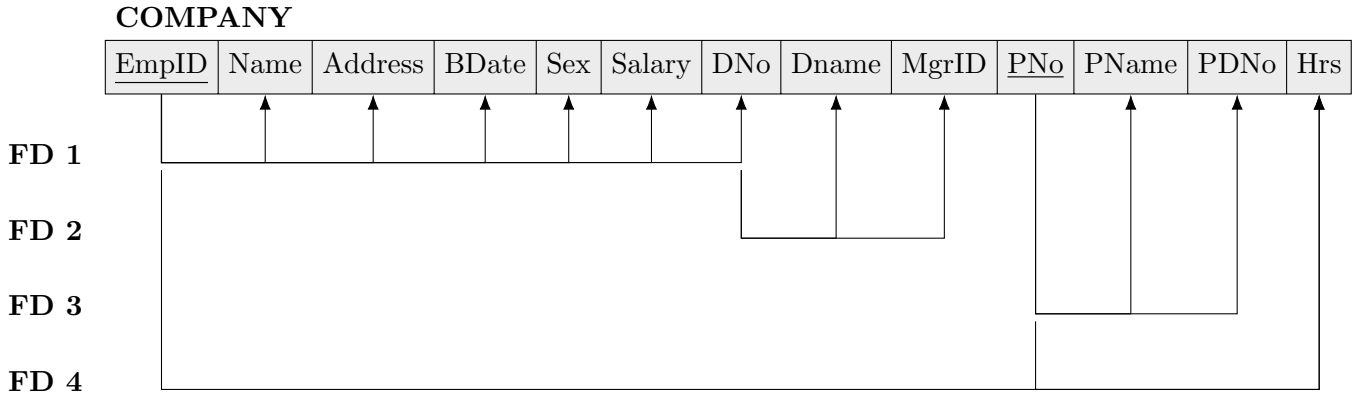

Figure 1: **COMPANY** Relation

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.

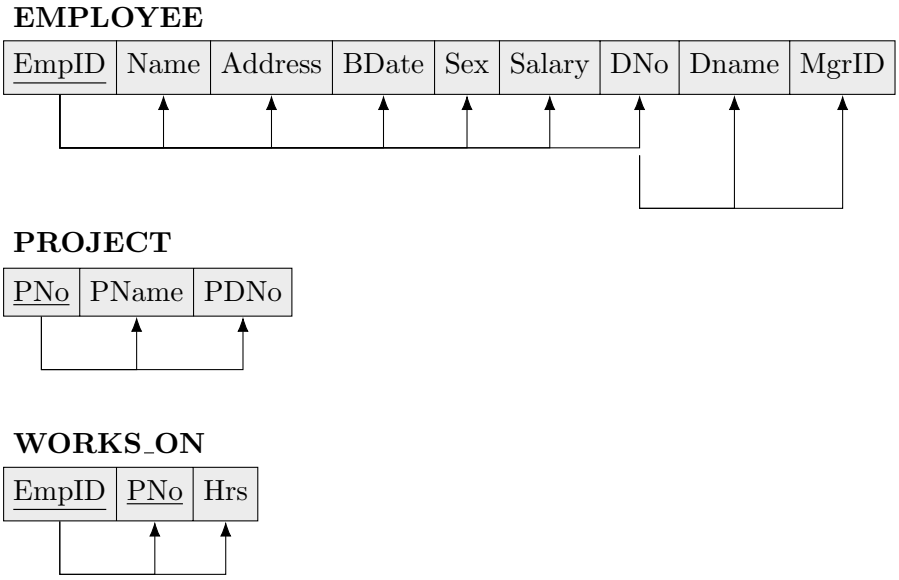

Figure 2: Decomposition after 2NF

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.

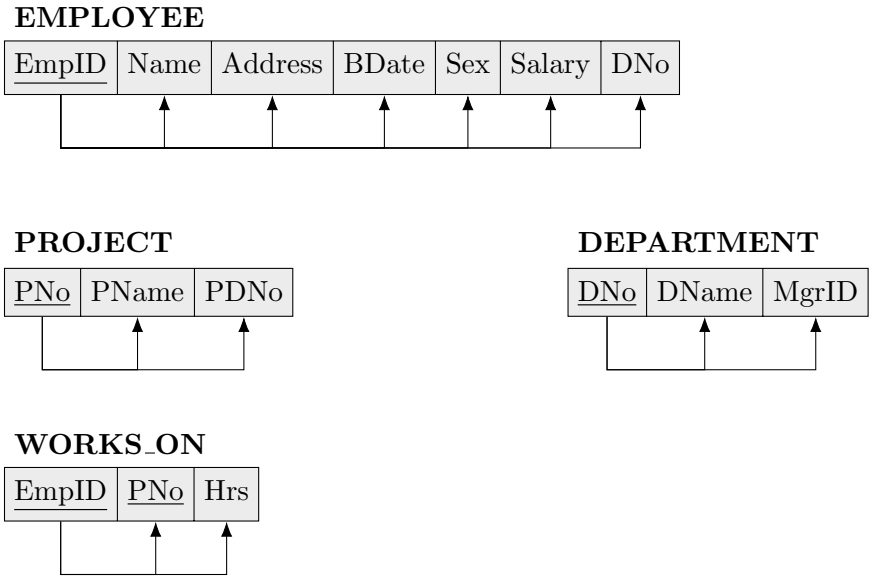

Figure 3: Decomposition after 3NF

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

1. Joining the **EMPLOYEE** and **DEPARTMENT** relations.

Name	EmpID	Bdate	Address	Sex	Salary	DNo	DName	MgrID
John B Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	5	Research	333445555
Franklin T Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	5	Research	888665555
Alicia J Zelaya	999887777	1969-01-19	3321 Castle, Spring, TX	F	25000	4	Administration	987654321
Jennifer S Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	4	Administration	888665555
Ramesh K Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	5	Research	333445555
Joyce A English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	5	Research	333445555
Ahmad V Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	4	Administration	987654321
James E Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	1	Headquarters	NULL

Table 1: EMPLOYEE $\bowtie$ DEPARTMENT

2. Joining the **PROJECT** and **WORKS_ON** relations.

EmpID	PNo	Hrs	Pname	PDNo
123456789	1	32.5	ProductX	5
123456789	2	7.5	ProductY	5
666884444	3	40.0	ProductZ	5
453453453	1	20.0	ProductX	5
453453453	2	20.0	ProductY	5
333445555	2	10.0	ProductY	5
333445555	3	10.0	ProductZ	5
333445555	10	10.0	Computerization	4
333445555	20	10.0	Reorganization	1
999887777	30	30.0	Newbenefits	4
999887777	10	10.0	Computerization	4
987987987	10	35.0	Computerization	4
987987987	30	5.0	Newbenefits	4
987654321	30	20.0	Newbenefits	4
987654321	20	15.0	Reorganization	1
888665555	20	NULL	Reorganization	1

Table 2: PROJECT $\bowtie$ WORKS_ON

3. Joining the 2 relations in Table 1 and Table 2

EmpID	PNo	Hrs	Pname	PDNo	Name	Bdate	Address	Sex	Salary	DNo	DName	MgrID
123456789	1	32.5	ProductX	5	John B Smith	1965-01-09	731 Fondren, Houston, TX	M	30000	5	Research	333445555
123456789	2	7.5	ProductY	5	John B Smith	1965-01-09	731 Fondren, Houston, TX	M	30000	5	Research	333445555
666884444	3	40.0	ProductZ	5	Ramesh K Narayan	1962-09-15	975 Fire Oak, Humble, TX	M	38000	5	Research	333445555
453453453	1	20.0	ProductX	5	Joyce A English	1972-07-31	5631 Rice, Houston, TX	F	25000	5	Research	333445555
453453453	2	20.0	ProductY	5	Joyce A English	1972-07-31	5631 Rice, Houston, TX	F	25000	5	Research	333445555
333445555	2	10.0	ProductY	5	Franklin T Wong	1955-12-08	638 Voss, Houston, TX	M	40000	5	Research	888665555
333445555	3	10.0	ProductZ	5	Franklin T Wong	1955-12-08	638 Voss, Houston, TX	M	40000	5	Research	888665555
333445555	10	10.0	Computerization	4	Franklin T Wong	1955-12-08	638 Voss, Houston, TX	M	40000	5	Research	888665555
333445555	20	10.0	Reorganization	1	Franklin T Wong	1955-12-08	638 Voss, Houston, TX	M	40000	5	Research	888665555
999887777	30	30.0	Newbenefits	4	Alicia J Zelaya	1969-01-19	3321 Castle, Spring, TX	F	25000	4	Administration	987654321
999887777	10	10.0	Computerization	4	Alicia J Zelaya	1969-01-19	3321 Castle, Spring, TX	F	25000	4	Administration	987654321
987987987	10	35.0	Computerization	4	Ahmad V Jabbar	1969-03-29	980 Dallas, Houston, TX	M	25000	4	Administration	987654321
987987987	30	5.0	Newbenefits	4	Ahmad V Jabbar	1969-03-29	980 Dallas, Houston, TX	M	25000	4	Administration	987654321
987654321	30	20.0	Newbenefits	4	Jennifer S Wallace	1941-06-20	291 Berry, Bellaire, TX	F	43000	4	Administration	888665555
987654321	20	15.0	Reorganization	1	Jennifer S Wallace	1941-06-20	291 Berry, Bellaire, TX	F	43000	4	Administration	888665555
888665555	20	NULL	Reorganization	1	James E Borg	1937-11-10	450 Stone, Houston, TX	M	55000	1	Headquarters	NULL

Table 3: COMPANY Relation with **16 tuples**

$\therefore$ The lossless join property has been verified since there are 16 tuples after re-joining the relations.

B Database Design Using ER Diagram

B.1 ER Diagram From Requirements

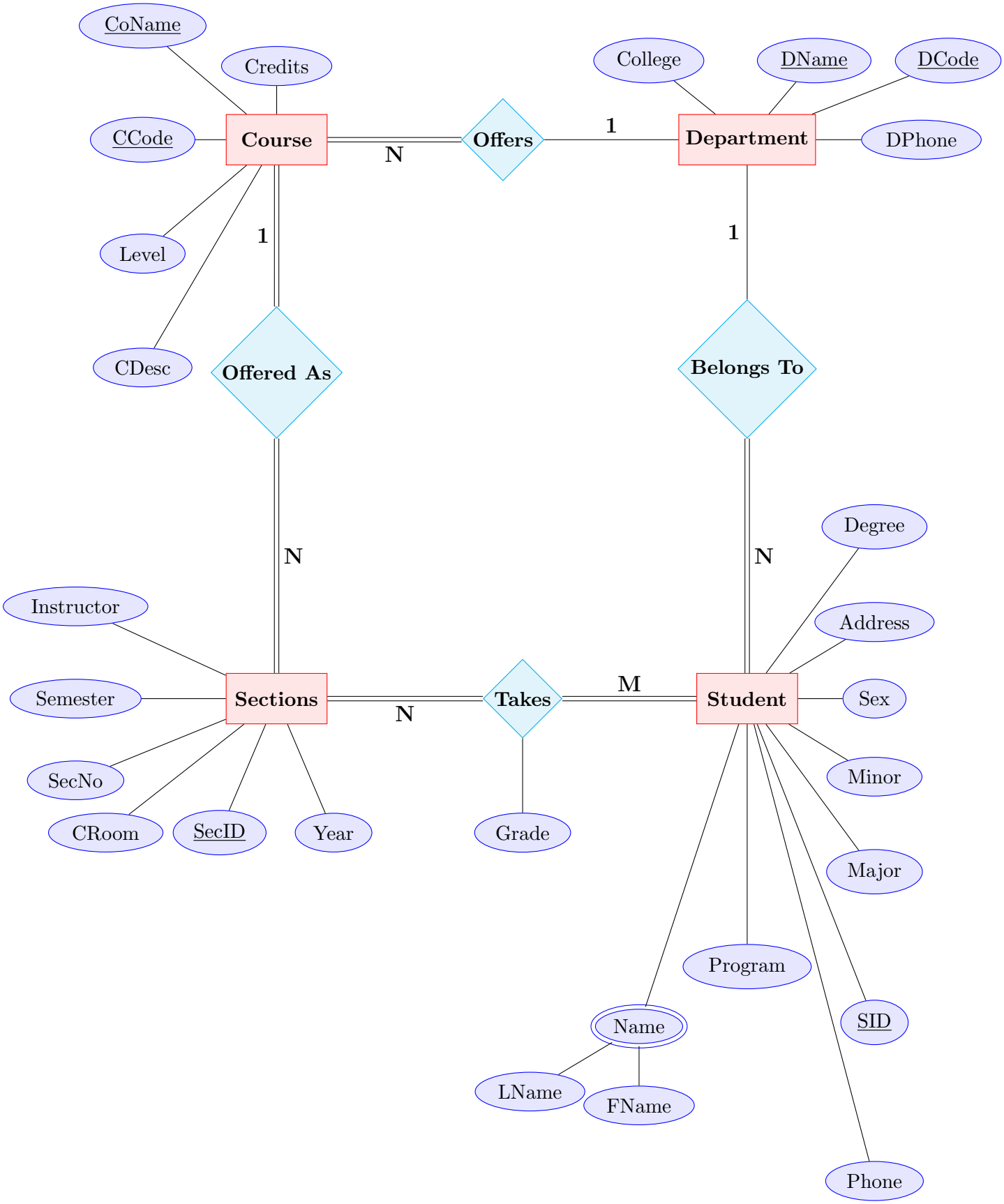

Figure 4: ER Diagram

B.2 ER Relational Mapping

The following was done to convert the ER Diagram 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.

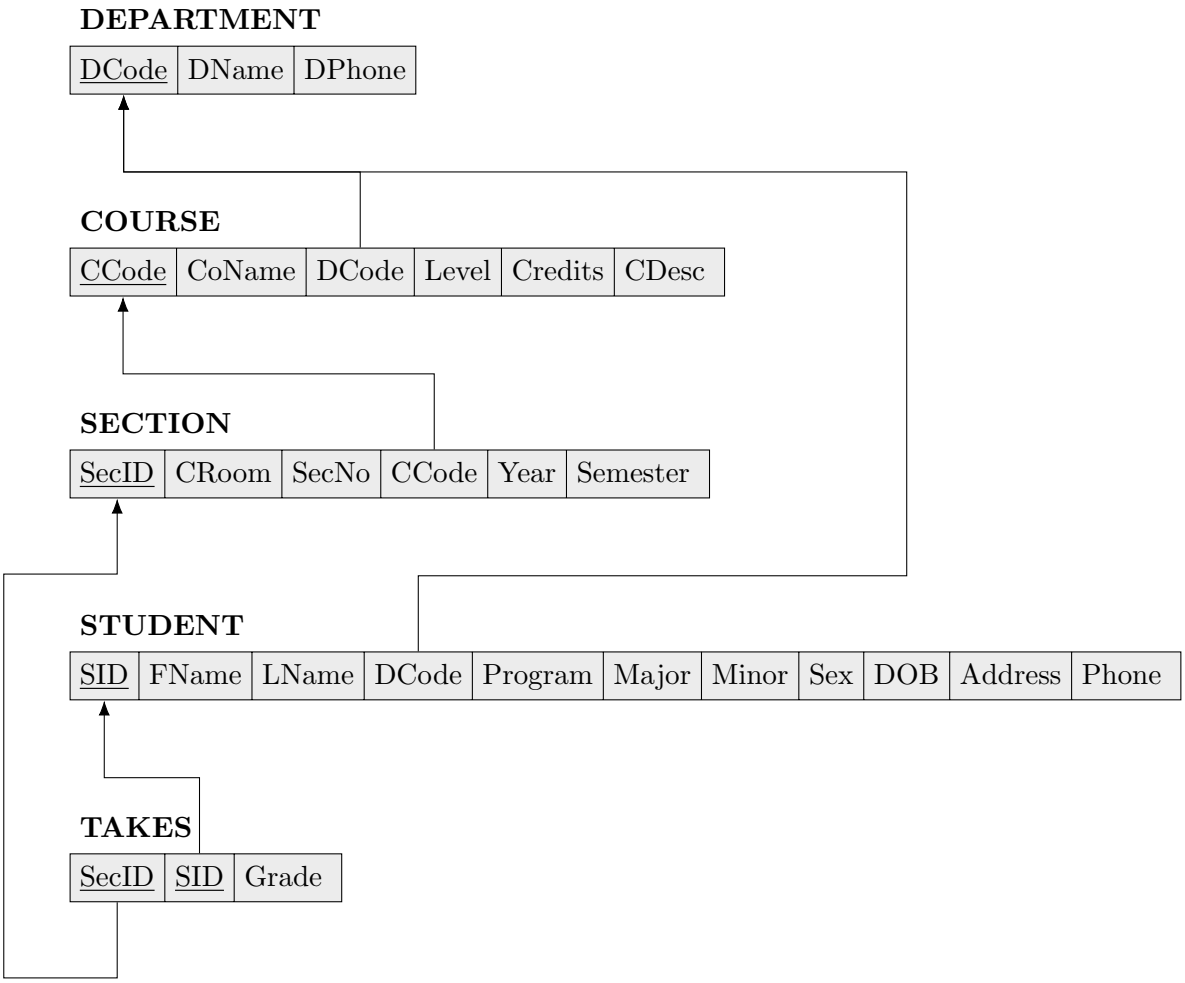

Figure 5: Schema Diagram