Final Project

CISC 660 Database Management Systems

Project Option II
University Database

NOVA SOUTHEASTERN UNIVERSITY

Under the guidance of
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1. PARTITION THE SENTENCES

[1]. University (Common Sentence)

- In a university, we represent data about both students and employees.

[2]. Student

- The university keeps track of each student's name, student number, social security number, address, phone, birth date, sex, class (freshman, graduate), major department, minor department (if any), and degree program (B.A., B.S., M.A., M.S., ..., Ph.D.). Some user applications need to access the city, state, and zip code of the student's address and the student last name. Both social security number and student number have unique values for each student.
- Students may have a transcript for all the courses they have taken. For graduate students, the student’s advisor should be included in the database.

[3]. Department

- Each department is described by a name, department number, office number, office phone, and college. Both department name and department number have unique values for each department. Each department has a Chairperson or a Dean in charge of that department.

[4]. Course

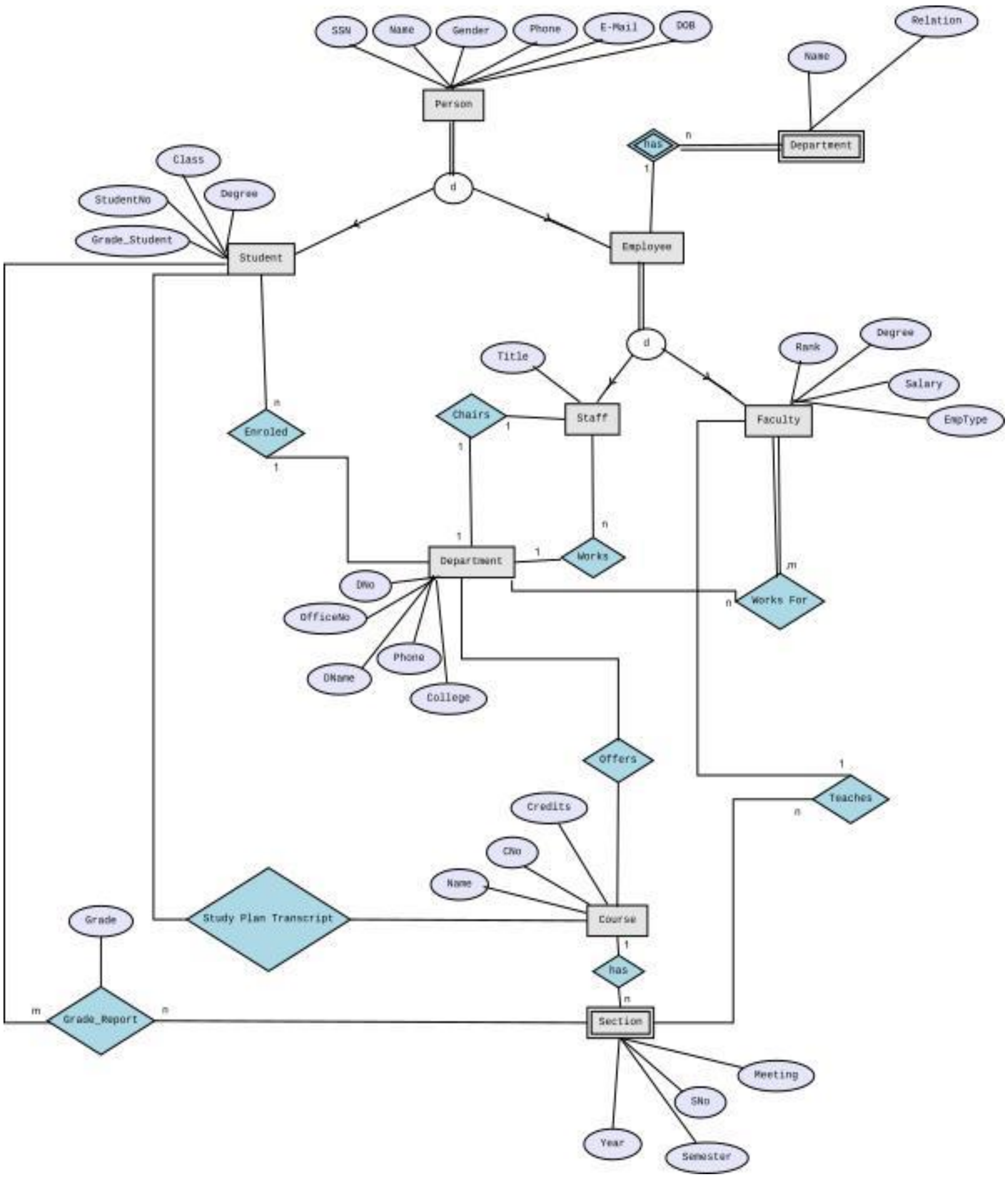
- Some courses have prerequisites (please pay attention here). Each course has the day, meeting time, place where the class is held.
- Each section has an instructor, semester, year, course, and section number. The section number distinguishes different sections of the same course that is taught during the same semester/year (may be at the same time), its values are 1, 2, 3, ..., up to the number of sections taught during each semester.
- A grade report for a course has student names, section number, and grades.

[5]. Employees

- Employees are classified into faculty and staff, both of them have dependents, the database stores the information of employees' dependents for the insurance and benefit purposes.
- Faculty could be full-time or part-time employees. Professors have ranks (Lecturer, Assistant Professor, Associate Professor, Full Professor) and salaries. Faculties (Professors) may hold different degree (highest degree is only considered here). Each professor belongs to at least one department. Professors may have joint appointments from other department(s).
- Staff are secretaries, program coordinators, assistant directors, directors, deans, vice presidents, and president

2. ER Diagram and CSDL

[1]. ER Diagram



[2]. Conceptual Schema in CSDL

1) Entity Person

Attribute Name	Type	Description
SSN	VARCHAR	Unique identifier for each user
Gender	Char	Gender
Name	VARCHAR	Composite Attribute – FirstName, MiddleName, LastName
DataOfBirth	Date	Date of Birth
Phone	VARCHAR	Phone Number
Email	VARCHAR	Email
Address	VARCHAR	Composite Attribute – Street, City, State, Zip

```
/* Defination of entity PERSON */
Entity:         PERSON
Attributes:             SSN          VARCHAR(10)
                        GENDER       CHAR
                        NAME         VARCHAR2(15)
                        DOB          DATE
                        NAME          VARCHAR2(20)
                        ADDRESS      VARCHAR2(20)

Identifiers:            SSN
```

2) Entity Student

Attribute Name	Type	Description
StudentNo	VARCHAR	Unique identifier for Student
Class	VARCAHR	Student's class
DegreeProg	VARCHAR	Degree Program in which student is enrolled.

```
/* Defination of entity STUDENT */
Entity:         STUDENT
Attributes:             STUDENTNO    VARCHAR(10)
                        CLASS        VARCHAR(10)
                        DEGREEPRO     VARCHAR2(15)

Identifiers:            STUDENTNO
```

3) Entity extending from Student – Grad_Student

4) Entity extending from Employee – Faculty and Staff

5) Entity Staff

Attribute Name	Type	Description
Title	**VARCHAR**	**Staff's title**

/* Defination of entity STAFF */
Entity: STAFF
Attributes: TITLE VARCHAR(10)

Identifiers: TITLE

6) Entity Faculty

Attribute Name	Type	Description
Rank	VARCHAR	Faculty's Rank
Degree	VARCHAR	Faculty's Degree
Salary	Number	Faculty's Salary
EmpType	VARCHAR	Full Time/Part Time

/* Defination of entity FACULTY */
Entity: FACULTY

Attributes:	RAB	VARCHAR(10)
	DEGREE	VARCHAR(10)
	SALARY	VARCHAR2(15)
	EMPTYPE	VARCHAR(10)

7) Entity Dependent

Attribute Name	Type	Description
Name	VARCHAR	Dependent's Name
Relation	VARCHAR	Dependent's Relation with Employee

/* Defination of entity DEPENDENT */
Entity: DEPENDENT

Attributes:	NAME	VARCHAR(10)
	RELATION	VARCHAR(10)

8) Entity Department

Attribute Name	Type	Description
DName	VARCHAR	Department Name, Unique Identifier
DNo	VARCHAR	Department Number, Unique Identifier

College	VARCHAR	College in which department is present
Phone	VARCHAR	Department Phone No
OfficeNo	VARCHAR	Office No.

/* Defination of entity DEPARTMENT */
Entity: DEPARTMENT

Attributes:	DNAME	VARCHAR(10)
	DNO	VARCHAR(10)
	COLLEGE	VARCHAR2(15)
	PHONE	VARCHAR(10)

Identifiers: DNAME

9) Entity Course

Attribute Name	Type	Description
CNo	VARCHAR	Course Number, Unique Identifier
Name	VARCHAR	Course Name
Credits	VARCHAR	Course Credits

/* Defination of entity COURSE */
Entity: COURSE

Attributes:	CNO	VARCHAR(10)
	NAME	VARCHAR(10)
	CREDITS	VARCHAR2(15)

Identifiers: CNO

10) Entity Semester

Attribute Name	Type	Description
Sno	VARCHAR	Serial Number, Part of Primary Key
Year	VARCHAR	Semester year, Part of Primary Key
Semester	VARCHAR	Semester No, Part of Primary Key
Meeting	VARCHAR	Composite Attribute - Time, Day and Room

/* Defination of entity SEMESTER */
Entity: SEMESTER
Attributes: SNO VARCHAR(10)

YEAR	VARCHAR(10)
SEMESTER	VARCHAR2(15)
MEETING	VARCHAR(10)

Identifiers: SNO

Following generalization exists:

- Person is super type of Employee and Student
- Employee is super type of Faculty and Staff
- Student is super type of Grad_Student

Following Relationship exists:

- Employee has dependents. There exists one to many relationship between Employee and Dependent.
- Staff Chairs Department. There exists one to one relationship between Staff and Department as only 1 staff member can chair the department at one time.
- Staff works for department. There exists one to many relationship between Department and Staff.
- Faculty works for department. There exists many to many relationship between Faculty and Department.
- Faculty teaches Section. There exists one to many relationship between Faculty and Section
- Student is enrolled in Department. There exists one to many relationship between Department and Student.
- Many –to-many relationship exist between Course and Student for Study Plan and Transcript
- Many-to-many relationship exists between Student and Section.
- A Department can offer one or many courses at a time. So there exists one to many relationship between Department and Course.

3. Relational Database Schema

1. **Person (<u>SSN</u>** VARCHAR, **FIRSTNAME** VARCHAR, **MIDDLENAME** VARCHAR, **LASTNAME** VARCHAR, **GENDER** CHAR, **PHONE** VARCHAR, **EMAIL** VARCHAR, **STREET** VARCHAR, **CITY** VARCHAR, **STATE** VARCHAR, **ZIP** VARCHAR, **DATEOFBIRTH** DATE**)**

   - **Functional Dependencies**

   a) SSN → FIRSTNAME, MIDDLENAME, LASTNAME, GENDER, PHONE, EMAIL, DATEOFBIRTH

   b) ZIP → STREET, CITY, STATE

   - **Primary Key** → SSN

2. **Employee** (**<u>SSN</u>** VARCHAR)

   - **PRIMARY KEY** → SSN
   - **FOREIGN KEY** → SSN
   - Here SSN refer to SSN in Person table for maintaining referential integrity.

3. **DEPENDENT (name** VARCHAR**, EESSN** VARCHAR**, Relation)**

    - **Primary Key** → NAME**,** EESSN
    - **FOREIGN KEY** → EESSN
    - Here EESSN refers to SSN in Employee table, thus maintain referential integrity.

4. **STUDENT (<u>SSN</u>** VARCHAR**, STUDENTNO** VARCHAR**, CLASS** VARCHAR**, DEGREEPROG** VARCHAR**, MINORDEPT** VARCHAR**, MAJORDEPT** VARCHAR**)**
    - **Functional Dependencies**
    a) SSN → STUDENTNO, CLASS, DEGREEPROG, MINORDEPT, MAJORDEPT
    b) STUDENTNO → SSN, CLASS, DEGREEPROG, MINORDEPT, MAJORDEPT
    - **Primary Key** → SSN
    - **Foreign Key** → SSN**,** MINORDEPT**,** MAJORDEPT
    - Here SSN is the foreign key referring to SSN in Person table and MINORDEPT and MAJORDEPT are referring to DEPTNO in Department table.

5. **STAFF (<u>SSN</u>** VARCHAR**, title** VARCHAR**, DEPTNO)**
    - **Functional Dependency**
    a) SSN → title, DEPTNO
    - **Primary Key** → SSN
    - **Foreign Key** → SSN
    - Here SSN is the foreign Key referring to SSN in Person table and DEPTNO is the foreign key referring to DNO in Department table.

6. **FACULTY (<u>SSN</u>** VARCHAR**, RANK** VARCHAR**, DEGREE** VARCHAR**, SALARY** NUMBER (10,2), **EMPTYPE** VARCHAR**)**
    - **Functional Dependency**
    a) SSN → RANK, DEGREE, SALARY, EMPTYPE
    - **Primary Key** → SSN
    - **Foreign Key** → SSN
    - Here SSN is the foreign Key referring to SSN in Person table.

7. **DEPARTMENT (<u>DNO</u> VARCHAR, DNAME VARCHAR, COLLEGE VARCHAR, OFFICENO** VARCHAR**, PHONE** VARCHAR**, CHAIRPERSON** VARCHAR**)**
    - **Functional Dependences**
    a) DNO → DNAME, COLLEGE, OFFICENO, PHONE, CHAIRPERSON
    b) DNAME → DNO, COLLEGE, OFFICENO, PHONE, CHAIRPERSON
    - **Candidate Keys** → DNO**,** DNAME
    - **Primary Key** → DNO
    - **Foreign Key** → CHAIRPERSON
    - Chairperson is the SSN referring to SSN in Person table.

8. **WORKS_FOR (<u>FAC_SSN</u>** VARCHAR**, <u>DEPTNO</u>** VARCHAR**)**
    - **Primary Key** → FAC_SSN, DEPTNO

- **Foreign Key** → FAC_SSN, DEPTNO
- Here FAC_SSN is the foreign Key referring to SSN in Faculty table and DEPTNO is the foreign key referring to DNO in Department table.

9. **COURSE (<u>CNO</u>** VARCHAR**, COURSENAME** VARCHAR**, CREDITS** NUMBER**, DEPTNO** VARCHAR**)**
   - **Functional Dependencies**

   a) CNO → COURSENAME, CREDITS, DEPTNO
   - **Primary Key** → CNO
   - **Foreign Key** → DEPTNO
   - Here DEPTNO is the foreign key referring to DNO in Department table.

10. **STUDYPLAN (<u>STU_SSN</u>** VARCHAR**, <u>COURSENO</u>** VARCHAR**)**
    - **Primary Key** → STU_SSN**,** COURSENO
    - **Foreign Key** → STU_SSN**,** COURSENO
    - STU_SSN is the foreign key referring to SSN in Student table and COURSENO is the foreign key referring to CNO in Course table.

11. **TRANSCRIPT (<u>STU_SSN</u>** VARCHAR**, <u>COURSENO</u>** VARCHAR**, GRADE** VARCHAR**)**
    - **Functional Dependency**

    a) STU_SSN, COURSENO → GRADE
    - **Primary Key** → STU_SSN, COURSENO
    - **Foreign Key** → STU_SSN, COURSENO

12. **SECTION (<u>SNO</u>** VARCHAR**, <u>SEMESTER</u>** VARCHAR**, <u>YEAR</u>** VARCHAR**, DAY** VARCHAR**, TIME** VARCHAR**, ROOM** VARCHAR**, FACULTY** VARCHAR**, <u>COURSENO</u>** VARCHAR**)**
    - **Functional Dependency**

    a) SNO, SEMESTER, YEAR, COURSENO →DAY, TIME, ROOM, FACULTY
    - **Primary Key** → SNO
    - **Foreign Key** → FACULTY**,** COURSENO
    - Here Faculty is the foreign key referring to SSN in Faculty table and CourseNo is the foreign key referring to CNO in Course table.

13. **GRADE_REPORT (<u>STU_SSN</u>** VARCHAR**, <u>SNO</u>** VARCHAR**, <u>SEMESTER</u>** VARCHAR**, <u>YEAR</u>** NUMBER**, <u>COURSENO</u>** VARCHAR**, GRADE** VARCHAR**)**
    - **Functional Dependency**

    a) STU_SSN, SNO, SEMESTER, YEAR, COURSENO → GRADE
    - **Primary Key**→STU_SSN, SNO, SEMESTER, YEAR, COURSENO
    - **Foreign Key** → STU_SSN, { SNO, SEMESTER, YEAR, COURSENO}
    - Here STU_SSN is the foreign key referring to SSN in Student table and {SNO, SEMESTER, YEAR, COURSENO} is referring to primary key of Semester table.

4. Join Paths

- Join Condition between Person and Student is through **SSN. Person.SSN = Student.SSN.**
- Join Condition between Person and Employee is through **SSN. Person.SSN = Employee.SSN.**
- Join Condition between Employee and Staff is through **SSN. Employee.SSN = Staff.SSN.**
- Join Condition between Employee and Faculty is through **SSN. Employee.SSN = Faculty.SSN.**
- Join Condition between Employee and Dependent is through **SSN. Employee.SSN = Dependent.EESSN.**
- Join Condition between Student and Department is through MINORDEPT and MAJORDEPT. **Student.MINORDEPT = Department.MINORDEPT and Student.MAJORDEPT = Department.MAJORDEPT**.
- Join Condition between Staff and Department is through CHAIRPERSON for chairs relation. **Department.CHAIRPERSON = Staff.SSN..**
- Join Condition between Staff and Department is through DNO for Works relation. **Staff.SSN=Department.SSN**
- Join Condition between Faculty and Department is through **DNO. Faculty.DEPTNO = Department.DNO.**
- Join Condition between Faculty and WORKS_FOR is through **SSN. Faculty.SSN = WORKS_FOR.FAC_SSN.**
- Join Condition between Department and WORKS_FOR is through **DNO. Department.DNO= WORKS_FOR.DEPTNO.**
- Join Condition between Department and Course is through **DNO. Department.DNO = Course.DEPTNO.**
- Join Condition between Student and Transcript is through **SSN. Student.SSN = Transcript.STU_SSN.**
- Join Condition between Course and Transcript is through CNO. **Course.CNO=Transcript.CourseNo.**
- Join Condition between Student and Study Plan is through **SSN. Student.SSN = STUDYPLAN.STU_SSN.**
- Join Condition between Course and Study Plan is through CNO. **Course.CNO=STUDYPLAN.CourseNo.**
- Join Condition between Section and Faculty is through faculty **ssn. Faculty.SSN = Section.Faculty.**
- Join Condition between Student and GRADE_REPORT is through Student **SSN. Student.SSN = GRADE_REPORT.STU_SSN.**
- Join Condition between Section and Grade_Report is through Section’s primary key **Section.SNO = Grade_Report.SNO, Section.Semester = Grade_Report.Semester, Section.year = Grade_Report.year and Section.CourseNo = Grade_Report.CourseNo.**

5. Normalization

1. **Person (**SSN VARCHAR, FIRSTNAME VARCHAR, MIDDLENAME VARCHAR, LASTNAME VARCHAR, GENDER CHAR, PHONE VARCHAR, EMAIL VARCHAR,DATEOFBIRTH DATE, ZIP VARCHAR**)**
    - In Person table, There exists a functional dependency of Street, City, State on Zip Code, so Person table can be split into Address tables in order to be in 3 NF.

2. **Address** (ZIP VARCHAR ,STREET VARCHAR, CITY VARCHAR,STATE VARCHAR)
    - Primary Key for Address table is Zip.
    - Zip in Person table is the foreign key referring to Zip in Address table for maintaining referential integrity.
    - All other entities described in relational database schema are in 3NF. There exists functional dependency and no transitive dependency.

3. **DEPENDENT (name** VARCHAR**, EESSN** VARCHAR**, Relation)**
    - **Primary Key** → NAME**,** EESSN
    - **FOREIGN KEY** → EESSN
    - Here EESSN refers to SSN in Employee table, thus maintain referential integrity.
    - There are no multivalued attributes, all the nonkey attributes are functionally dependent the primary key attribute and there is no transitive property. Therefore, there is no need to normalize the table. It is in 3NF.

4. **STUDENT (SSN** VARCHAR**, STUDENTNO** VARCHAR**, CLASS** VARCHAR**, DEGREEPROG** VARCHAR**, MINORDEPT** VARCHAR**, MAJORDEPT** VARCHAR**)**
    - **Primary Key** → SSN
    - **Foreign Key** → SSN**,** MINORDEPT**,** MAJORDEPT
    - Here SSN is the foreign key referring to SSN in Person table and MINORDEPT and MAJORDEPT are referring to DEPTNO in Department table.
    - There are no multivalued attributes, all the nonkey attributes are functionally dependent the primary key attribute and there is no transitive property. Therefore, there is no need to normalize the table. It is in 3NF.

5. **STAFF (SSN** VARCHAR**, title** VARCHAR**, DEPTNO)**
    - **Primary Key** → SSN
    - **Foreign Key** → SSN
    - Here SSN is the foreign Key referring to SSN in Person table and DEPTNO is the foreign key referring to DNO in Department table.
    - There are no multivalued attributes, all the nonkey attributes are functionally dependent the primary key attribute and there is no transitive property. Therefore, there is no need to normalize the table. It is in 3NF.

6. **FACULTY (SSN** VARCHAR**, RANK** VARCHAR**, DEGREE** VARCHAR**, SALARY** NUMBER(10,2)**, EMPTYPE** VARCHAR**)**

- **Primary Key →** SSN
- **Foreign Key →** SSN
- Here SSN is the foreign Key referring to SSN in Person table.
- There are no multivalued attributes, all the nonkey attributes are functionally dependent the primary key attribute and there is no transitive property. Therefore, there is no need to normalize the table. It is in 3NF.

7. **DEPARTMENT (<u>DNO</u>** VARCHAR**, DNAME** VARCHAR**, COLLEGE** VARCHAR**, OFFICENO VARCHAR,** PHONE **VARCHAR, CHAIRPERSON** VARCHAR**)**
   - **Primary Key →** DNO
   - **Foreign Key →** CHAIRPERSON
   - Chairperson is the SSN referring to SSN in Person table.
   - There are no multivalued attributes, all the nonkey attributes are functionally dependent the primary key attribute and there is no transitive property. Therefore, there is no need to normalize the table. It is in 3NF.

8. **WORKS_FOR (<u>FAC_SSN</u>** VARCHAR**, <u>DEPTNO</u>** VARCHAR**)**
   - **Primary Key →** FAC_SSN**,** DEPTNO
   - **Foreign Key →** FAC_SSN, DEPTNO
   - Here FAC_SSN is the foreign Key referring to SSN in Faculty table and DEPTNO is the foreign key referring to DNO in Department table.
   - There are no multivalued attributes, all the nonkey attributes are functionally dependent the primary key attribute and there is no transitive property. Therefore, there is no need to normalize the table. It is in 3NF.

9. **COURSE (<u>CNO</u>** VARCHAR**, COURSENAME** VARCHAR**, CREDITS** NUMBER**, DEPTNO** VARCHAR**)**
   - **Primary Key →** CNO
   - **Foreign Key →** DEPTNO
   - Here DEPTNO is the foreign key referring to DNO in Department table.
   - There are no multivalued attributes, all the nonkey attributes are functionally dependent the primary key attribute and there is no transitive property. Therefore, there is no need to normalize the table. It is in 3NF.

10. **STUDYPLAN (<u>STU_SSN</u>** VARCHAR**, <u>COURSENO</u>** VARCHAR**)**
    - **Primary Key →** STU_SSN, COURSENO
    - **Foreign Key →** STU_SSN, COURSENO
    - STU_SSN is the foreign key referring to SSN in Student table and COURSENO is the foreign key referring to CNO in Course table.
    - There are no multivalued attributes, all the nonkey attributes are functionally dependent the primary key attribute and there is no transitive property. Therefore, there is no need to normalize the table. It is in 3NF.

11. **TRANSCRIPT (<u>STU_SSN</u>** VARCHAR**, <u>COURSENO</u>** VARCHAR**, GRADE** VARCHAR**)**
    - **Primary Key →** STU_SSN, COURSENO

- **Foreign Key →** STU_SSN, COURSENO
- There are no multivalued attributes, all the nonkey attributes are functionally dependent the primary key attribute and there is no transitive property. Therefore, there is no need to normalize the table. It is in 3NF.

12. SECTION (SNO VARCHAR**, SEMESTER** VARCHAR**, YEAR** VARCHAR**, DAY** VARCHAR**, TIME** VARCHAR**, ROOM** VARCHAR**, FACULTY** VARCHAR**, COURSENO** VARCHAR**)**

- **Primary Key →** SNO
- **Foreign Key →** FACULTY, COURSENO
- Here Faculty is the foreign key referring to SSN in Faculty table and CourseNo is the foreign key referring to CNO in Course table.
- There are no multivalued attributes, all the nonkey attributes are functionally dependent the primary key attribute and there is no transitive property. Therefore, there is no need to normalize the table. It is in 3NF.

13. GRADE_REPORT (STU_SSN VARCHAR**, SNO** VARCHAR**, SEMESTER** VARCHAR**, YEAR** NUMBER**, COURSENO** VARCHAR**, GRADE** VARCHAR**)**

- **Primary Key→**STU_SSN, SNO, SEMESTER, YEAR, COURSENO
- **Foreign Key →** STU_SSN, { SNO, SEMESTER, YEAR, COURSENO}
- Here STU_SSN is the foreign key referring to SSN in Student table and {SNO, SEMESTER, YEAR, COURSENO} is referring to primary key of Semester table.
- There are no multivalued attributes, all the nonkey attributes are functionally dependent the primary key attribute and there is no transitive property. Therefore, there is no need to normalize the table. It is in 3NF.

6. Implement the Relational Database

[1]. Creating tables

```
SQL> create table Address
  2  (
  3  zip varchar(5) primary key,
  4  street varchar(30),
  5  city varchar(30),
  6  state varchar(20)
  7  );

Table created.

SQL> create table Person
  2  (
  3  ssn varchar(10) primary key,
  4  firstName varchar(20) not null,
  5  middleName char(20),
  6  lastName varchar(20) not null,Gender varchar(1),
  7  dob date,
  8  zip varchar(5),
  9  phone varchar(10),
 10  FOREIGN KEY (zip) REFERENCES Address (zip)
 11  );

Table created.

SQL> create table employee
  2  (
  3  ssn varchar(10) not null,
  4  FOREIGN KEY (ssn) REFERENCES Person (ssn)
  5  );

Table created.

SQL> create table Dependent
  2  (
  3  name varchar(20) not null,
  4  essn varchar(10) not null,
  5  relation varchar(20),
  6  constraint depPK primary key (name,essn)
  7  );

Table created.
SQL> create table Department
  2  (
  3  dno varchar(10) primary key,
  4  dname varchar(10) not null,
  5  college varchar(10),
  6  officeNo varchar(10),
  7  chairperson varchar(10),
  8  constraint dnameUK unique (dname)
  9  );

Table created.
SQL> create table Staff
  2  (
  3  ssn varchar(10) primary key,
  4  title varchar(10),
  5  deptno varchar(10),
  6  FOREIGN KEY (ssn) REFERENCES Employee (ssn),
  7  FOREIGN KEY (deptno) REFERENCES Department (dno)
  8  );

Table created.

SQL> create table Faculty
  2  (
  3  ssn varchar(10) primary key,
  4  degree varchar(10),
  5  rank varchar(20),
  6  EmpType varchar(10),
  7  deptNo varchar(10),
  8  FOREIGN KEY (ssn) REFERENCES Employee (ssn)
  9  );

Table created.

SQL> create table Student
  2  (
  3  ssn varchar(10) primary key,
  4  studentNo varchar(10) not null,
  5  degreeProg varchar(5),
  6  minorDept varchar(10),
  7  majorDept varchar(10),
  8  class varchar(10),
  9  FOREIGN KEY (ssn) REFERENCES Person(ssn),
 10  FOREIGN KEY (minorDept) REFERENCES Department (dno),
 11  FOREIGN KEY (majorDept) REFERENCES Department (dno),
 12  constraint snoUK unique (studentNo)
 13  );

Table created.
SQL> create table Works_For
  2  (
  3  facSSN varchar(10) not null,
  4  deptNo varchar(10) not null,
  5  constraint worksForPK primary key (facSSN,deptNo),
  6  FOREIGN KEY (facSSN) REFERENCES Faculty (ssn),
  7  FOREIGN KEY (deptNO) REFERENCES DEpartment (dno)
  8  );

Table created.
SQL> create table Course
  2  (
  3  cno varchar2(10) not null,
  4  cname varchar2(50),
  5  credits number(5),
  6  deptNo varchar(10) not null,
  7  FOREIGN KEY (deptNo) REFERENCES Department (dno)
  8  );

Table created.
SQL> create table Study_Plan
  2  (
  3  stuSSN varchar(10) not null,
  4  courseNo varchar(10) not null,
  5  constraint studyplanPK primary key (stuSSN,courseNO),
  6  FOREIGN KEY (stuSSN) REFERENCES Student (ssn),
  7  FOREIGN KEY (courseNO) REFERENCES Course(cno)
  8  );

Table created.
SQL> create table Transcript
  2  (
  3  stuSSN varchar(10) not null,
  4  courseNo varchar(10) not null,
  5  grade varchar(2) not null,
  6  constraint transcriptPK primary key (stuSSN,courseNo),
  7  FOREIGN KEY (stuSSN) REFERENCES Student(ssn),
  8  FOREIGN KEY (courseNo) REFERENCES Course (cno)
  9  );

Table created.
SQL> create table Section
  2  (
  3  sno varchar(10) not null,
  4  semester varchar(10) not null,
  5  year number(4) not null,
  6  meetingDay varchar(10),
  7  meetingTime varchar(10),
  8  meetingRoom varchar(10),
  9  instructor varchar(10),
 10  courseNo varchar(10) not null,
 11  constraint sectionPK primary key (sno,semester,year,courseNo),
 12  FOREIGN KEY (instructor) REFERENCES Faculty (ssn),
 13  FOREIGN KEY (courseNo) REFERENCES Course (cno)
 14  );

Table created.
SQL> create table Grade_Report
  2  (
  3  stuSSN varchar(10) not null,
  4  sno varchar(10) not null,
  5  semester varchar(10) not null,
  6  year number(4) not null,
  7  courseNo varchar(10) not null,
  8  grade varchar(2),
  9  constraint gradereportPK primary key
(stuSSN,sno,semester,year,courseNo),
 10  FOREIGN KEY (stuSSN) REFERENCES Student (ssn),
 11  FOREIGN KEY (sno,semester,year,courseNo) REFERENCES Section
(sno,semester,year,courseNo)
 12  );

Table created.
SQL> create table Salary_Scale
  2  (
  3  rank varchar(20) not null,
  4  empType varchar(9) not null,
  5  salary number(8,2),
  6  constraint ssPK primary key (rank,empType)
  7  );

Table created.

SQL> create table Grad_Student
  2  (
  3  stuSSN varchar(10) primary key,
  4  facSSN varchar(10) not null,
  5  FOREIGN KEY (stuSSN) REFERENCES Faculty (ssn),
  6  FOREIGN KEY (facSSN) REFERENCES Student (ssn)
  7  );

Table created.
SQL> create table Course_Prerequisite
  2  (
  3  cno varchar(10) not null,
  4  precno varchar(10) not null,
  5  constraint cprPK primary key (cno,precno),
  6  FOREIGN KEY (cno) REFERENCES Course (cno),
  7  FOREIGN KEY (precno) REFERENCES Course (cno)
  8  );

Table created.
```

[2]. Entering values into the tables

1. Address

```
SQL> insert into Address values('65432', '2001 M
Rent','Hialeah','SF');

1 row created.

SQL> insert into Person
values('765439876','Mike','S','Smith','M','11-MAR-
85','65432','8765554334');

1 row created.

SQL> insert into Address values('23121','2121 B Street','Belle
Grove','NY');

1 row created.

SQL> insert into Address values('09867','2    North
      Street','Coconut Beach','NY');

1 row created.

SQL> insert into Address values('98765','31 Westside
street','Parkgate',    'JK');

1 row created.

SQL> insert into Address values('09809','71   MC
      Street','Markland','FY');

1 row created.
SQL> insert into Address values('33328', 'Apt 14', 'Davie','FL');

1 row created.

SQL> insert into Address values('33389','8210 SW 41
CT','Davie','FL');

1 row created.

SQL> insert into Address values('09956','8130 NW 21 ST','Coconut
Beach', 'FL');

1 row created.

SQL> insert into Address values('98764','Ap 21','Coral Springs',
      'FL');

1 row created.

SQL> insert into Address values('09803','71   MC
      Street','Miami','FL');

1 row created.
```

2. Person

```
SQL>               insert               into               Person
values('865361231','Patty','P','Preston','F','01-APR-
72','23121','0988342133');

1 row created.

SQL> insert into Person
values('875435123','Megan','M','Woods','F','21-OCT-
89','09867','5674398764');

1 row created.

SQL> insert into Person
values('875676767','Chris','V','Seilr','M','26-JUL-
78','98765','6775545422');

1 row created.

SQL> insert into Person
values('864542278','John','L','Carry','M','10-AUG-
81','09809','652457732');

1 row created.
SQL>               insert               into               Person
values('975164333','Shaival','P','Shah','M','12-DEC-
93','33328','9856712572');

1 row created.

SQL>               insert               into               Person
values('743678246','Gaurav','P','Jain','M','01-JUN-
94','33389','0988342781');

1 row created.

SQL> insert into Person
values('952561853','Shreeraj','F','Pawar','M','21-OCT-
93','09956','5674398757');

1 row created.

SQL>
SQL> insert into Person
values('942567194','Jaimin','V','Patel','M','26-JUL-
94','98764','6775543674');

1 row created.

SQL> insert into Person
values('864169257','Priyana','L','Chwada','F','10-AUG
94','09803','6524569843');

1 row created.
```

3. Employee

```
SQL> insert into Employee values('865361231');

1 row created.

SQL> insert into Employee values('875435123');

1 row created.

SQL> insert into Employee values('875676767');

1 row created.

SQL> insert into Employee values('864542278');

1 row created.
```

4. Department

```
SQL> insert into Department           values(3,'Pharmacy','PHMD',
'098762286','CN543');

1 row created.

SQL> insert into Department  values(1,'Computer  Science','CISC',
'779646655','CS123');

1 row created.

SQL> insert into Department                 values(2,'Information
Technology','MSIT','658537372','IT456');

1 row created.
```

5. Staff

```
SQL> insert into Staff values('765439876','Dean',1);

1 row created.

SQL> insert into Staff values('865361231','Coordinator',2);

1 row created.

SQL> insert into Staff values('875435123','Dean',3);

1 row created.

SQL> insert into Staff values('875676767','Coordinator',3);

1 row created.

SQL> insert into Staff values('864542278','Dean',2);
```

```
1 row created.
```

6. Faculty

```
SQL> insert into Faculty    values('865361231',
      'MCA','Assistant Professor','PART-TIME',1);

1 row created.

SQL> insert into Faculty    values('875676767',
      'MPhil','Assistant Professor','PART-TIME',2);

1 row created.

SQL> insert into Faculty    values('875435123',
      'PHD','Permanent Professor','FULL-TIME',3);

1 row created.

SQL> insert into Faculty    values('765439876',
      'PHD','Permanent Professor','FULL-TIME',1);

1 row created.
```

7. Course

```
SQL> insert into Course values('CS2','Computer Networking',3,1);

1 row created.

SQL> insert into Course values('CS3','Operating Systems',3,2);

1 row created.

SQL> insert into Course values('CS4','Computer Architecture',3,2);

1 row created.

SQL> insert into Course values('CS5','Data Strucutures',3,2);

1 row created.
```

8. COURSE_PREREQUISITE

```
SQL> insert into COURSE_PREREQUISITE values   ('CS1','CS3');

1 row created.

SQL> insert into COURSE_PREREQUISITE values   ('CS2','CS4');

1 row created.
```

9. SALARY_SCALE

```
SQL> insert into SALARY_SCALE values ('Lecturer',   'part-time',
      110000);
```

```
1 row created.

SQL> insert into SALARY_SCALE values ('Lecturer',   'full-time',
     123431.54);

1 row created.

SQL> insert into   SALARY_SCALE   values   ('Associate   Professor',
     'full-time',     753532.45);

1 row created.
```

10. Student

```
SQL> insert into Student                       values('975164333',
     'SN201','BCA',1,3,'graduate');

1 row created.

SQL> insert into Student    values('743678246',
     'SN202','MCA',3,1,'graduate');

1 row created.

SQL> insert into Student    values('952561853',
     'SN203','PHD',2,3,'phd');

1 row created.

SQL> insert into Student    values('942567194',
     'SN204','BSC',1,3,'freshman');

1 row created.

SQL> insert into Student    values('864169257',
     'SN205','PHD',null,1,'phd');

1 row created.
```

11. Dependent

```
SQL> insert into Dependent values('Richard','098762286','Spouse');

1 row created.

SQL> insert into Dependent values('Michel','779646655',  'Son');

1 row created.

SQL> insert into Dependent                               values('Kim
maggio','753338862','Spouse');

1 row created.

SQL> insert into Dependent values('Garry','962371274','daughter');

1 row created.
```

```
SQL> insert into Dependent values('Sheron','658537372','Son');

1 row created.
```

12. WORKS_FOR

```
SQL> insert into WORKS_FOR values('765439876',1);

1 row created.

SQL> insert into WORKS_FOR values('865361231',3);

1 row created.

SQL> insert into WORKS_FOR values('875676767',2);

1 row created.

SQL> insert into WORKS_FOR values('875435123',1);

1 row created.
```

13. Section

```
SQL> insert into Section
values(1,'summer',2017,'monday','11:00AM','Desantis301',
'865361231','CS2');

1 row created.

SQL> insert into Section
      values(2,'winter',2017,'tuesday','10:00AM','Desantis401',
'875676767','CS2');

1 row created.

SQL> insert into Section
      values(1,'summer',2017,'fridat','09:00AM',    'Desantis401',
'865361231','CS1');

1 row created.

SQL> insert into Section    values(1,'summer',2017,
      'thursday','04:30PM',  'Desantis401', '875435123','CS4');

1 row created.

SQL> insert into Section    values(1,'summer',2017,
      'monday','06:30PM', 'Desantis401','765439876','CS5');

1 row created.
```

14. STUDY_PLAN

```
SQL> insert into STUDY_PLAN values('864169257','CS1');

1 row created.
```

```
SQL> insert into STUDY_PLAN values('942567194','CS2');

1 row created.

SQL> insert into STUDY_PLAN values('952561853','CS3');

1 row created.

SQL> insert into STUDY_PLAN values('743678246','CS4');

1 row created.
```

15. Transcript

```
SQL> insert into Transcript values('952561853','CS1','A');

1 row created.

SQL> insert into Transcript values('743678246','CS2','A+');

1 row created.

SQL> insert into Transcript values('942567194','CS3','B');

1 row created.

SQL> insert into Transcript values('864169257','CS1','B+');

1 row created.
```

16. GRADE_STUDENT

```
SQL> insert into Grad_Student values(‘975164333’,’765439876’);

1 row created.

SQL> insert into Grad_Student values(‘743678246’,’765439876’);

1 row created.

SQL> insert into Grad_Student values(‘952561853’,’875435123’);

1 row created.

SQL> insert into Grad_Student values(‘942567194’,’875676767’);

1 row created.

SQL> insert into Grad_Student values(‘864169257’,’875676767’);

1 row created.
```

7. SQL Queries

1. Query 1

```
SQL> @u1
SQL> run
  1* select d.dname, count(*) from Department d left join Student
       s on d.dno = s.majorDept or d.dno = minorDept
group by dname

DNAME                          COUNT(*)
------------------------------ ----------
Computer Science                        4
Information Technology                  1
Pharmacy                                4
```

2. Query 2

```
SQL> @u2
SQL> run
  1  select d.dname, wf.facSSN as ssn, count(s.sno) as
       NoOfcourses from Department d left join Works_For wf on
       d.dno = wf.deptNo
  2* left join Section s on wf.facSSN = s.instructor
group by d.dname, wf.facSSN order by d.dname asc

DNAME                          SSN        NOOFCOURSES
------------------------------ ---------- -----------
Computer Science               765439876            4
Computer Science               875435123            1
Information Technology         875676767            1
Pharmacy                       865361231            0
```

3. Query 3

```
SQL> @u3
SQL> run
  1  select d.dname, c.cno, c.cname from Department d
  2* left join Course c on d.dno = c.deptNo group by
       d.dname, c.cno, c.cname order by d.dname asc

DNAME                          CNO
------------------------------ ----------
CNAME
--------------------------------------------------
Computer Science               CS1
Database

Computer Science               CS2
Computer Networking

Information Technology         CS3
Operating Systems


DNAME                          CNO
------------------------------ ----------
CNAME
```

```
---------------------------------------------------
Information Technology         CS4
Computer Architecture

Information Technology         CS5
Data Strucutures

Pharmacy



6 rows selected.
```

4. **Query 4**

```
SQL> @u4
SQL> run
  1  select c.cno,     p.precno    from  Course     c
  2  left   join  Course_Prerequisite    p on  c.cno =  p.cno  group
      by    c.cno,     p.precno
  3* order  by    c.cno asc

CNO        PRECNO
---------- ----------
CS1        CS3
CS2        CS4
CS3
CS4
CS5
```

5. **Query 5**

```
SQL> @u5
SQL> run
  1  select d.dname,   count(distinct   wf.facSSN)   as   prof_ct,
      count(load)/count(distinct   wf.facSSN) as    avgLoad   from
      Department  d
  2  left   join (select     deptNo, facSSN from Works_For)     wf
      on    wf. deptNo  =     d.dno left  join
  3* (select     count(*)  as load,  instructor  from  Section  group
      by instructor)   t on  wf.facSSN   =     t.instructor   group
      by    d.dname

DNAME                          PROF_CT    AVGLOAD
------------------------------ ---------- ----------
Information Technology                  1          1
Pharmacy                                1          0
Computer Science                        2          1
```

6. **Query 6**

```
SQL> @u6
SQL> run
  1  select d.dname as  stu_ct,     sum(t2.credits)   as    tl_cr,
      sum(t2.credits)/count(distinct t1.ssn) as avg_cr
  2  from Department   d,(select   ssn,  majorDept,  minorDept  from
      Student) t1,(select    c.credits,  t.stuSSN    as    ssn  from
      Transcript  t,    Course      c     where t.courseNo =  c.cno)
      t2
  3* where  (t1.majorDept=d.dno    or    t1.minorDept=d.dno)    and
      (t2.ssn=t1.ssn)  group by d.dname

STU_CT                              TL_CR     AVG_CR
------------------------------ ---------- ----------
Information Technology                  3          3
Pharmacy                                9          3
Computer Science                        9          3
```

7. **Query 7**

```
SQL> @u7
SQL> run
  1  select f.ssn,      stu.studentNo    from    Faculty    f    left
      join Section s on f.ssn      = s.instructor left    join
  Grade_Report g
  2  on s.sno    =     g.sno and   s.semester  =     g.semester  and
      s.year     =     g.year      and   s.courseNo  =
      g.courseNo left  join Student stu on    stu.ssn     =
      stuSSN
  3* group  by    f.ssn,      stu.studentNo order    by    f.ssn asc

SSN        STUDENTNO
---------- ----------
765439876  SN203
765439876  SN204
765439876  SN205
765439876
865361231
875435123  SN202
875676767

7 rows selected.
```

8. **Query 8**

```
SQL> @u8
SQL> run
  1  select f.ssn,      d.dname     from  Faculty     f     left
      join  Department  d
  2  on     exists      ((select    cno   from  Course      where
      deptNo      =     d.dno)      intersect
  3  (select      courseNo    from Section s    where s.instructor
      =     f.ssn))
  4* group  by    f.ssn,      d.dname     order by    f.ssn asc

SSN        DNAME
---------- ------------------------------
765439876  Computer Science
765439876  Information Technology
865361231
875435123  Information Technology
875676767  Computer Science
```

9. **Query 9**

```
SQL> @u9
SQL> run
  1  select d.dname, f.ssn from    Department  d      left      join
      Works_For wf
  2  on     d.dno =     wf.deptNo
  3  left   join  Faculty     f
  4  on     wf.facSSN   =     f.ssn
  5  left   join  Salary_Scale     ss
  6  on     f.rank      =     ss.rank    and    f.empType   =
      ss.empType  where (select     count(*)    from  Section
      where instructor  =     f.ssn)      >     2
  7* and    ss.salary   <     (select     avg(sal.salary)   from
      Faculty     fac,  Salary_Scale     sal,  Works_For         wf
      where fac.rank    =     sal.rank    and    fac.empType =
sal.empType and   wf.facSSN   =     fac.ssn     and    wf.deptNo   =
      d.dno) group by  d.dname, f.ssn

no rows selected
```

10. Query 10

```
SQL> @u10
SQL> run
  1  select ssn, count(stuSSN)     from Faculty
  2* left join Grad_Student on     ssn   =     facSSN      group  by
      ssn

SSN        COUNT(STUSSN)
---------- -------------
765439876              2
865361231              0
875435123              1
875676767              2
```

11. Query 11

```
SQL> @u11
SQL> run
  1  select dname,      count(*)  from    Department  inner join
Student     on     dno   =     majorDept   or    dno   =
      minorDept group   by    dname
  2* having count(*)    >     (select     avg(count)  from  (select
      count(*) as count from Department   inner join  Student     on
      dno    =     majorDept or     dno   =     minorDept group   by
      dno))

DNAME                          COUNT(*)
------------------------------ ----------
Computer Science                        4
Pharmacy                                4
```

12. Query 12

```
SQL> @u12
SQL> run
```

```
  1  select d.dname,    sum(s.salary)    as    avg_salary       from
      Department  d
  2  inner  join  Works_For   wf  on d.dno =     wf.deptNo  inner  join
      Faculty     f
  3  on     wf.facSSN   =     f.ssn  inner join   Salary_Scale    s    on
      f.rank      =     s.rank      and   f.empType   =
      s.empType  group   by    d.dname
  4  having sum(s.salary)    >     (select     avg(avg_salary)
      from  (select     d.dname,    sum(s.salary)     as
      avg_salary  from  Department  d
  5  inner  join  Works_For   wf    on    d.dno =     wf.deptNo
      inner join  faculty     f  on  wf.facSSN   =     f.ssn  inner
      join  Salary_Scale      s
  6* on     f.rank      =     s.rank      and   f.empType   =
      s.empType   group by    d.dname))

no rows selected
```

13. Query 13

```
SQL> @u13
SQL> run
  1  select d.dname, wf.facSSN,    count(g.facSSN)  as   count   from
      Department  d  left      join  Works_For  wf on     d.dno =
      wf.deptNo
  2  inner  join  (Grad_Student     g     inner join  Student    s   on
      g.stuSSN    =     s.ssn  and   s.degreeProg      =     'PHD')
      on     wf.facSSN   =     g.facSSN  group   by    d.dname,
      wf.facSSN,  d.dno
  3  having count(g.facSSN)   >     (select     avg(phd_count)   from
      (select     count(*)    as    phd_count
  4* from   Works_For   wf1,  Grad_Student     gs,   Student     stu
      where  wf1.deptNo  =     d.dno  and   wf1.facSSN   =
      gs.facSSN  and    gs.stuSSN   =     stu.ssn          and
      stu.degreeProg='PHD'))  order by    d.dname     asc

no rows selected
```

14. Query 14

```
SQL> @u14
SQL> run
  1  select s.ssn  from  Student     s  where     not  exists  ((select
      distinct  c.cno
  2  from   Course      c,    Course_Prerequisite    p          where
      c.deptNo=s.majorDept  and
  3* c.cno  =     p.precno)   minus  (select     courseNo    from
      Transcript  where  stuSSN      =     s.ssn))

SSN
----------
975164333
743678246
952561853
942567194
864169257
```

15. Query 15

```
SQL> @u15
SQL> run
  1  select stu.ssn     from Student stu  where not   exists
  2  ((select    s.courseNo from  Person      p,  Section  s  where
      p.ssn =     s.instructor and p.lastname  =     'Smith')
  3* minus (select     courseNo    from  Transcript  where stuSSN
      =     stu.ssn))

no rows selected
```

16. Query 16

```
SQL> @u16
SQL> run
  1  select distinct    stu.ssn
  2  from  Student     stu,  Transcript  t
  3  where  stu.ssn     =     t.stuSSN    and   not   exists   ((select
      courseNo    from
  4  Transcript   where  stuSSN=stu.ssn)  minus  (select  s.courseNo
       from
  5* Person p,    Section     s where     p.ssn =     s.instructor
      and   p.lastName  =     'Smith'))

SSN
----------
743678246
864169257
942567194
952561853
```

17. Query 17

```
SQL> @u17
SQL> run
  1  select stu.ssn     from  Student     stu    where not   exists
  2  ((select    t.courseNo  from  Person p, Transcript    t where
  3  p.ssn  =     t.stuSSN    and   p.firstName =     'Shaival')
  4* minus (select     courseNo    from  Transcript  where stuSSN
      =     stu.ssn))


SSN
----------
743678246
864169257
942567194
952561853
975164333
```

18. Query 18

```
SQL> @u18
SQL> run
  1  select stu.ssn     from  Student     stu    where not   exists
  2  ((select courseNO from Study_Plan  where stuSSN     =
      stu.ssn) minus
  3* (select     courseNo    from Transcript  where stuSSN        =
      stu.ssn     and   grade in    ('A', 'A-', 'B+', 'B',  'B-',
      'C+')))

SSN
----------
864169257
975164333
```

19. Query 19

```
SQL> @u19
SQL> run
  1  select stu.ssn     from Student     stu   where not   exists
  2  ((select courseNo from Study_Plan where  stuSSN     =
      stu.ssn) minus
  3* (select     courseNo    from  Transcript  where stuSSN      =
      stu.ssn))

SSN
----------
864169257
975164333

SQL> spool off
```