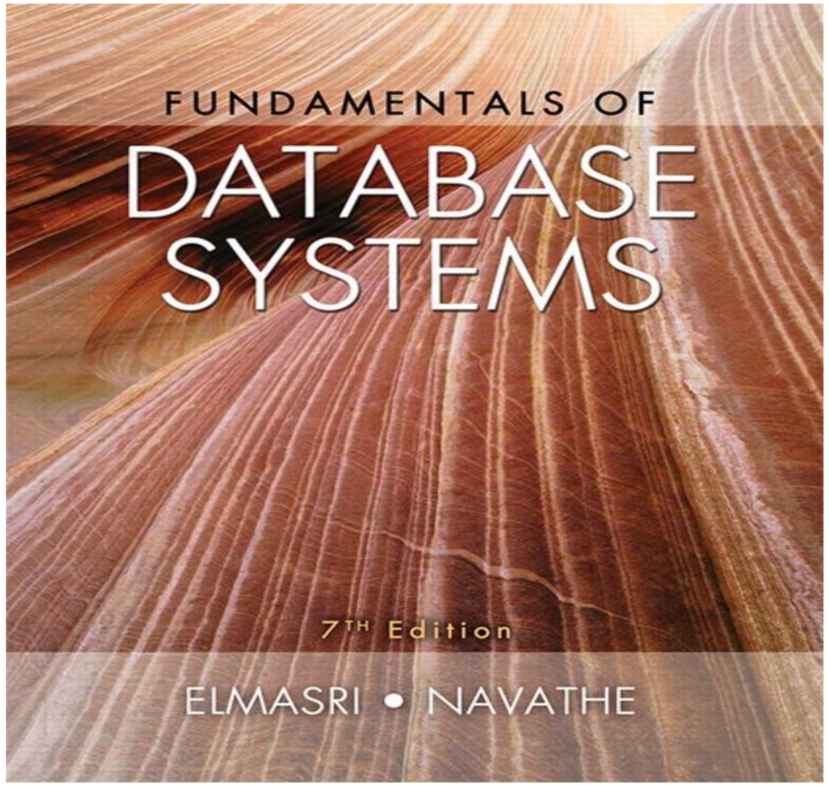
Comp-3150: Database Management Systems

- Ramez Elmasri, Shamkant B. Navathe(2016) Fundamentals of Database Systems (7th Edition), Pearson, isbn 10: 0-13-397077-9; isbn-13:978-0-13-397077-7.
- Chapter 6:
  BASIC SQL



Chapter 6: BASIC SQL: Outline

- 1. SQL Data Definition and Data Types
- 2. Specifying Constraints in SQL
- 3. Basic Retrieval Queries in SQL
- 4. INSERT, DELETE, and UPDATE Statements in SQL

1. SQL Data Definition and Data Types

- SQL language
  - Considered one of the major reasons for the commercial success of relational databases
- SQL stands for “structured Query Language” although it originally came from the word SEQUEL in its introduction.
- SQL is one of the major reasons for the success of the commercial relational model as it makes DB application migration easy with most DBMS’s using it.

1. SQL Data Definition and Data Types: SQL Standards

- SQL has gone through many standards: starting with SQL-86 or SQL 1. SQL-92 is referred to as SQL-2.
- Later standards (from SQL-1999) are divided into **core** specification and specialized **extensions**. The extensions are implemented for different applications – such as data mining, data warehousing, multimedia etc.
- SQL-2006 added XML features; In 2008 they added Object-oriented features.
- SQL-3 is the current standard which started with SQL-1999. It is not fully implemented in any RDBMS

1. SQL Data Definition and Data Types: SQL Standards

- Terminology:
  - **Table**, **row**, and **column** are used for the relational model terms relation, tuple, and attribute respectively.
- SQL language has features for :
  - 1. Data definition (called DDL or data definition language),
  - 2. Data Manipulation (called DML or data mainipulation language),
  - 3. Transaction control (Transact-SQL), (4) Indexing , (5) Security specification (Grant and Revoke), etc. (called data control lang. or DCL)
- `CREATE` statement
  - Main SQL command for data definition is the CREATE statement

1. SQL Data Definition and Data Types: The CREATE SCHEMA command in SQL

- We cover the basic standard SQL syntax – there are variations in existing RDBMS systems
- **1. SQL schema (that is the database):**
  - 1. Identified by a **schema name, and**
  - 2. Includes an **authorization identifier (eg 'Jsmith') to indicate the owner of the schema** and **descriptors** (eg. Grant select) for each element
- **Schema elements** include
  - Tables, constraints, views, domains, and other constructs
- Not all users are authorized to create schemas and schema elements.
- Each statement in SQL ends with a **semicolon**

1. SQL Data Definition and Data Types: The CREATE SCHEMA command in SQL

- For example, to create a database schema called COMPANY, use:
- `CREATE SCHEMA` statement
  - `CREATE SCHEMA COMPANY AUTHORIZATION 'Jsmith';`
- **The above does not list the schema elements and those can be defined later.**
- **Catalog**
  - Named collection of schemas in an SQL environment
  - A catalog contains a special schema called INFORMATION_SCHEMA for providing information on all schemas and element descriptors in these schemas.

1. SQL Data Definition and Data Types: The CREATE TABLE Command in SQL

- 2. The CREATE TABLE Command in SQL:
- Is used to specify a new relation and it:
  - Provides name of the table
  - Specifies attributes, their types and initial constraints
- Can optionally specify schema as:
  - `CREATE TABLE COMPANY.EMPLOYEE ...`

    or
  - `CREATE TABLE EMPLOYEE ...`
  - Note that the Oracle DBMS SQL implementation on our CS server has data types VARCHAR2 (not VARCHAR), NUMBER (not DECIMAL or INT).

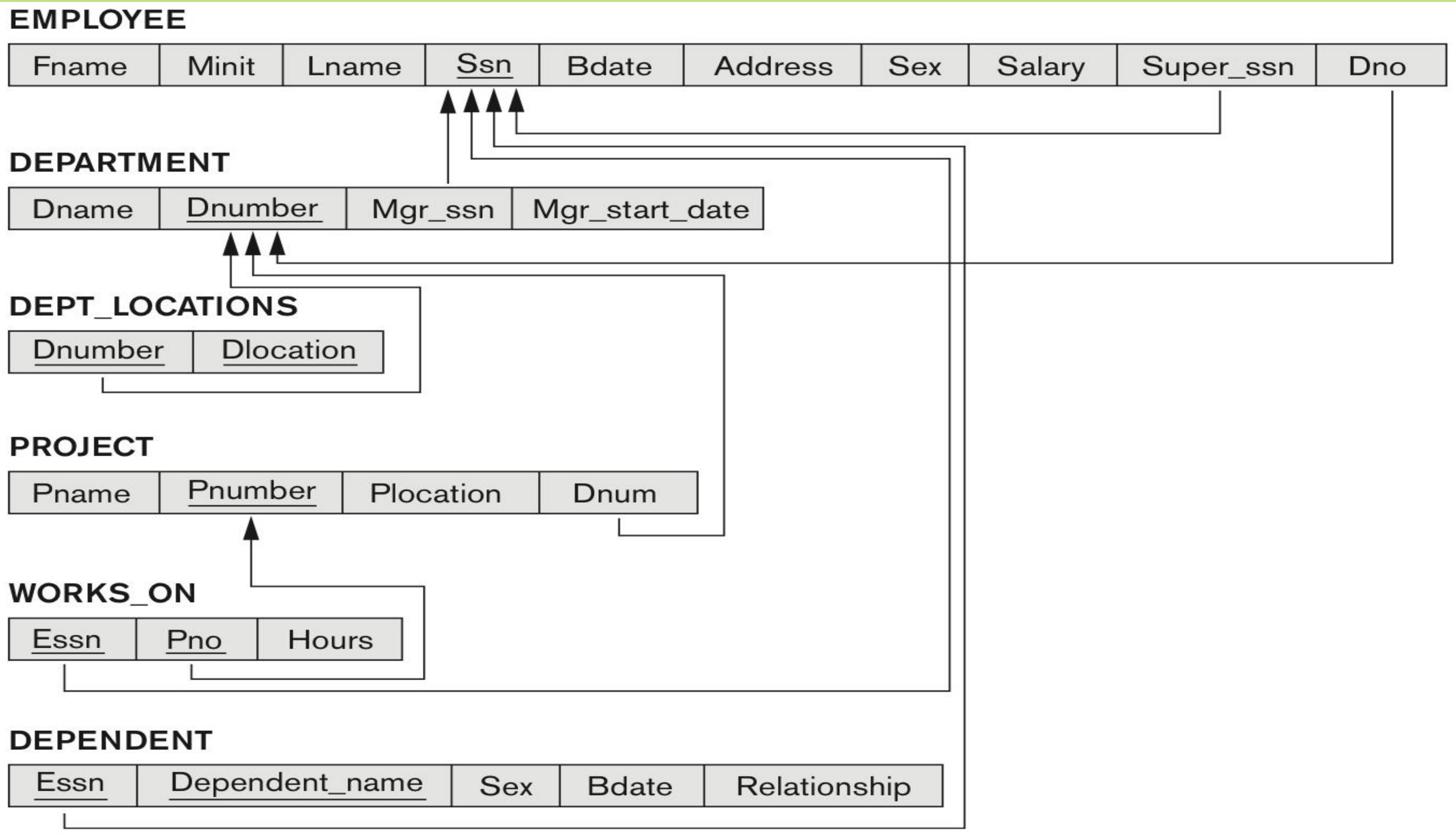
1. SQL Data Definition and Data Types: The CREATE TABLE Command in SQL

```
• CREATE TABLE EMPLOYEE
  (Fname VARCHAR2(15) NOT NULL,
   Minit CHAR,
   Lname VARCHAR2(15) NOT NULL,
   Ssn   CHAR(9)     NOT NULL,
   Bdate  DATE,
   Address VARCHAR2(15),
   Sex    CHAR,
   Salary DECIMAL(10, 2),
   Super_ssn CHAR(9),
   Dno    INT              NOT NULL,
   PRIMARY KEY(Ssn));
```

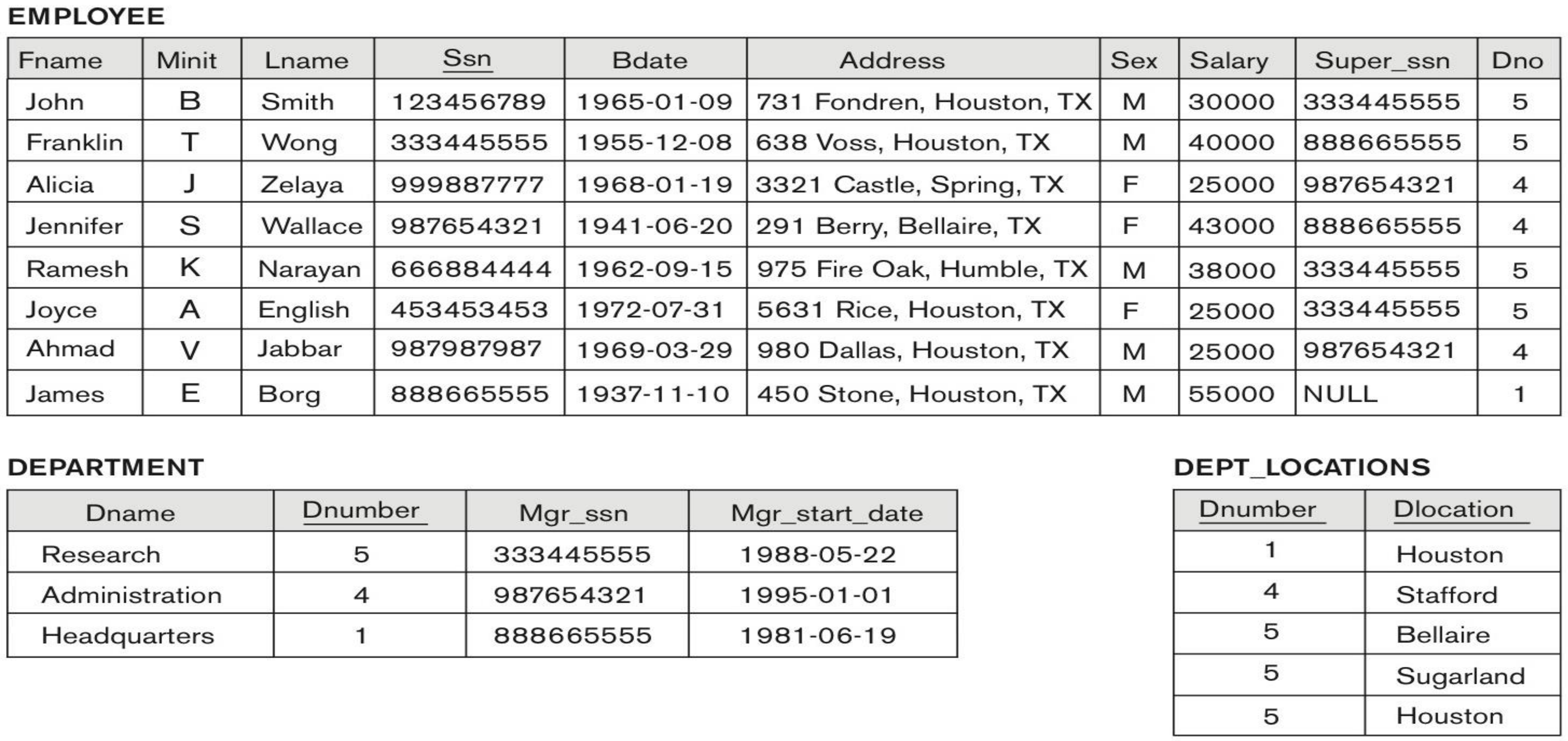
1. SQL Data Definition and Data Types: The CREATE TABLE Command in SQL

- **Base tables (base relations)**
  - Relation and its tuples are actually created and stored as a file by the DBMS
- **Virtual relations (views)**
  - Created through the `CREATE VIEW` statement. Do not correspond to any physical file.

1. SQL Data Definition and Data Types: COMPANY relational database schema (Fig. 5.7)



One possible database state for the COMPANY relational database schema (Fig. 5.6)



EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

One possible database state for the COMPANY relational database schema – continued (Fig. 5.6)

WORKS_ON

Essn	Pno	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	NULL

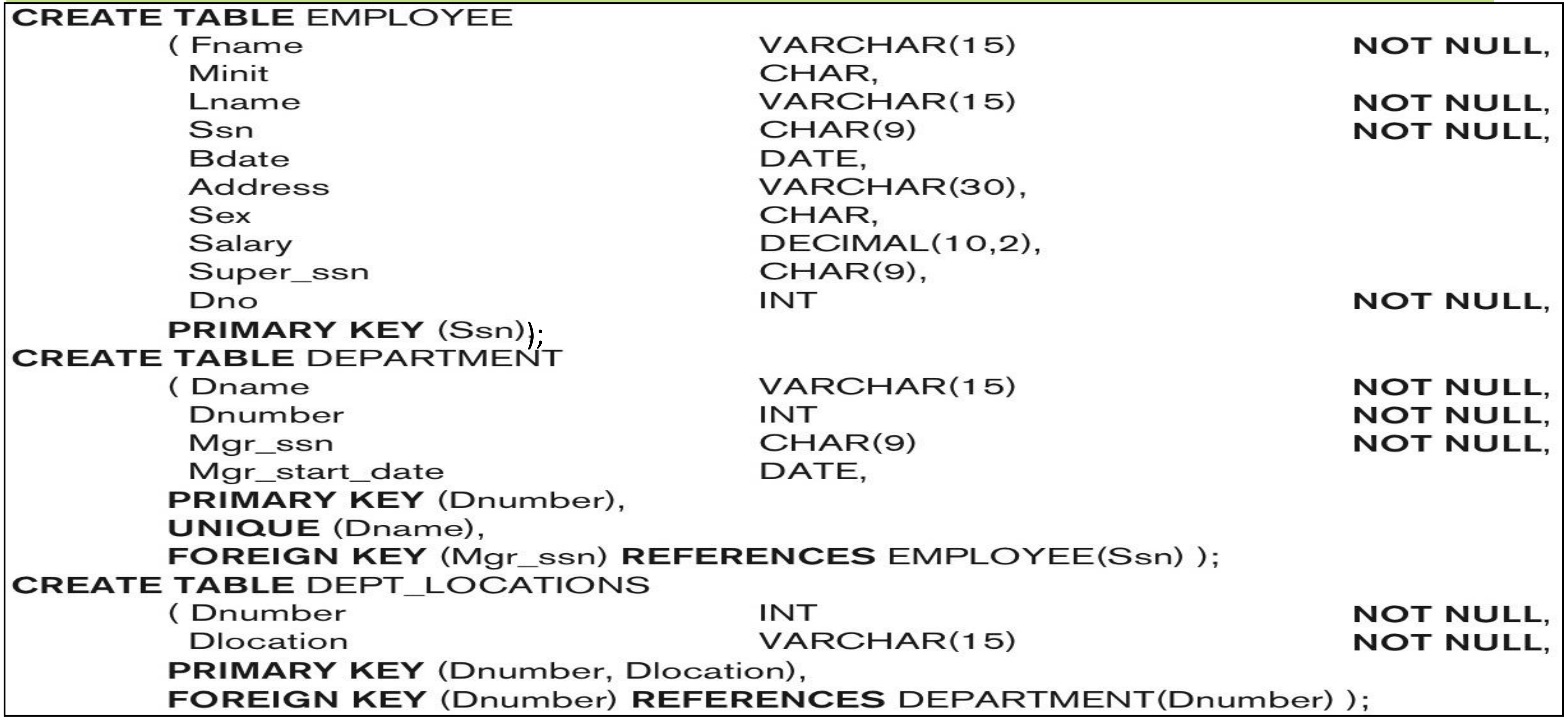
PROJECT

Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

DEPENDENT

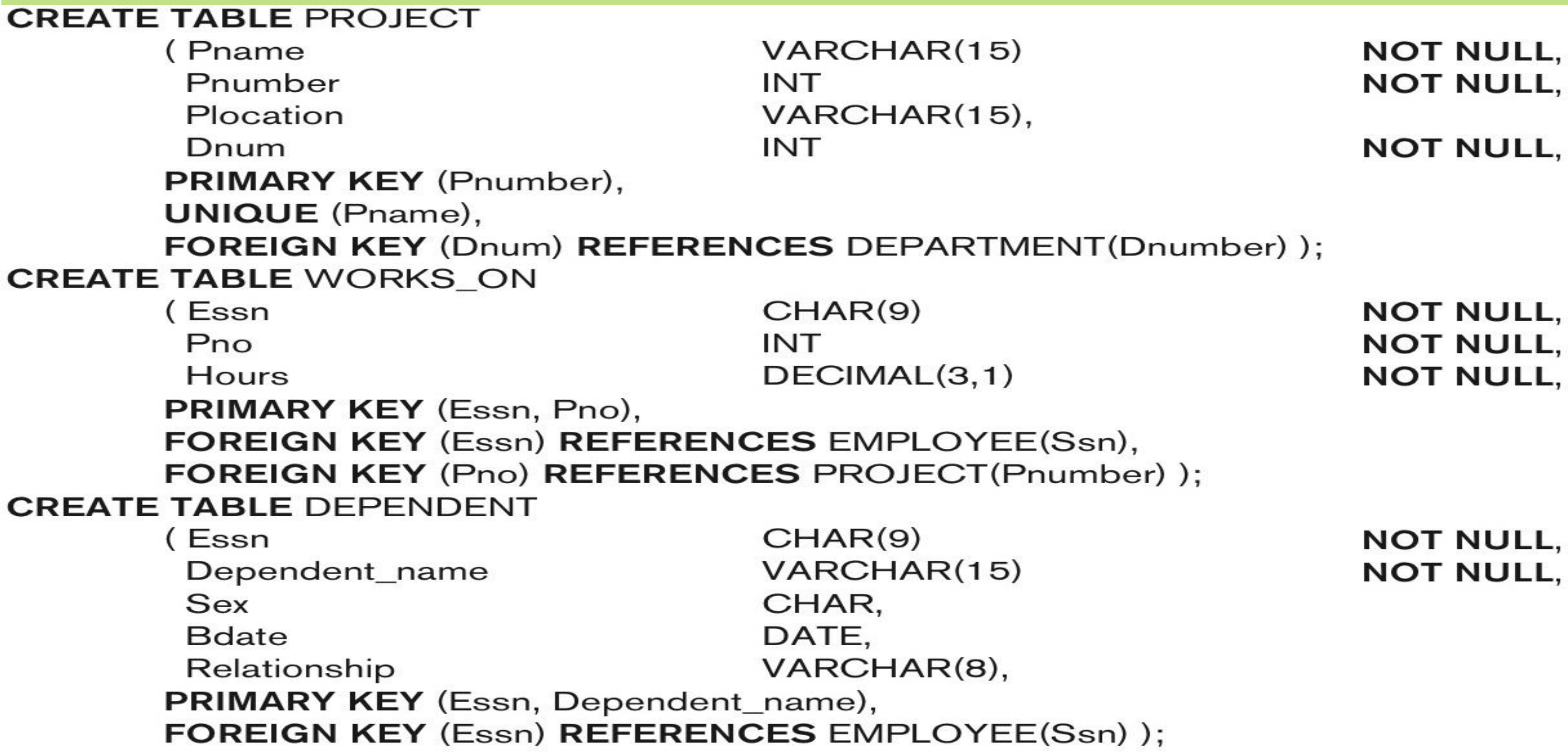
Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

SQL CREATE TABLE data definition statements for defining the COMPANY schema from Figure 5.7 (Fig. 6.1)



```
CREATE TABLE EMPLOYEE
        ( Fname                         VARCHAR(15)                 NOT NULL,
          Minit                         CHAR,
          Lname                         VARCHAR(15)                 NOT NULL,
          Ssn                           CHAR(9)                     NOT NULL,
          Bdate                         DATE,
          Address                       VARCHAR(30),
          Sex                           CHAR,
          Salary                        DECIMAL(10,2),
          Super_ssn                     CHAR(9),
          Dno                           INT                         NOT NULL,
        PRIMARY KEY (Ssn));
CREATE TABLE DEPARTMENT
        ( Dname                         VARCHAR(15)                 NOT NULL,
          Dnumber                       INT                         NOT NULL,
          Mgr_ssn                       CHAR(9)                     NOT NULL,
          Mgr_start_date                DATE,
        PRIMARY KEY (Dnumber),
        UNIQUE (Dname),
        FOREIGN KEY (Mgr_ssn) REFERENCES EMPLOYEE(Ssn) );
CREATE TABLE DEPT_LOCATIONS
        ( Dnumber                       INT                         NOT NULL,
          Dlocation                     VARCHAR(15)                 NOT NULL,
        PRIMARY KEY (Dnumber, Dlocation),
        FOREIGN KEY (Dnumber) REFERENCES DEPARTMENT(Dnumber) );
```

SQL CREATE TABLE data definition statements for defining the COMPANY schema from Figure 5.7 (Fig. 6.1)



```
CREATE TABLE PROJECT
        ( Pname                         VARCHAR(15)                     NOT NULL,
          Pnumber                       INT                             NOT NULL,
          Plocation                     VARCHAR(15),
          Dnum                          INT                             NOT NULL,
        PRIMARY KEY (Pnumber),
        UNIQUE (Pname),
        FOREIGN KEY (Dnum) REFERENCES DEPARTMENT(Dnumber) );
CREATE TABLE WORKS_ON
        ( Essn                          CHAR(9)                         NOT NULL,
          Pno                           INT                             NOT NULL,
          Hours                         DECIMAL(3,1)                    NOT NULL,
        PRIMARY KEY (Essn, Pno),
        FOREIGN KEY (Essn) REFERENCES EMPLOYEE(Ssn),
        FOREIGN KEY (Pno) REFERENCES PROJECT(Pnumber) );
CREATE TABLE DEPENDENT
        ( Essn                          CHAR(9)                         NOT NULL,
          Dependent_name                VARCHAR(15)                     NOT NULL,
          Sex                           CHAR,
          Bdate                         DATE,
          Relationship                  VARCHAR(8),
        PRIMARY KEY (Essn, Dependent_name),
        FOREIGN KEY (Essn) REFERENCES EMPLOYEE(Ssn) );
```

1. SQL Data Definition and Data Types: The CREATE TABLE Command

- Some foreign keys may cause errors
  - Specified either via:
    - Circular references
    - Or because they refer to a table that has not yet been created
  - Example circular reference is foreign key Super_ssn in EMPLOYEE table which refers to Ssn in the EMPLOYEE table.
  - The foreign key Dno in EMPLOYEE table refers to the DEPARTMENT table not yet created.
  - One solution to these problems is to leave the constraints out during the initial creation of the table and use the ALTER TABLE statement to change them when they can no longer cause a violation.

1. SQL Data Definition and Data Types: Attribute Data Types and Domains in SQL

- 3. Attribute Data Types and Domains in SQL

- Basic **data types (Six main types)**
  - **1. Numeric** data types
    - i. Integer numbers: `INTEGER`, `INT`, and `SMALLINT`
    - ii. Floating-point (real) numbers: `FLOAT` or `REAL`, and `DOUBLE PRECISION`
  - **2. Character-string** data types
    - i. Fixed length: `CHAR(`*n*`)`, `CHARACTER(`*n*`)`
    - ii. Varying length: `VARCHAR(`*n*`)`, `CHAR VARYING(`*n*`)`, `CHARACTER VARYING(`*n*`)`
    - `Varying large text: CHARACTER LARGE OBJECT or CLOB. Eg. CLOB(20M) specifies a maximum of 20MB of text.`

1. SQL Data Definition and Data Types: Attribute Data Types and Domains in SQL

- **3. Bit-string** data types
  - i. Fixed length: `BIT(n), e.g., B'10101'`
  - ii. Varying length: `BIT VARYING(n)`
  - `iii.BLOB,e.g. BLOB(30G) for large binary values like images.`
- **4. Boolean** data type
  - Values of `TRUE` or `FALSE` or `NULL`
- **5. DATE** data type
  - hasTen positions with Components as `YEAR`, `MONTH`, and `DAY` in the form YYYY-MM-DD
  - Multiple mapping functions available in RDBMSs to change date formats
  - Note that the date format on our CS system is dd-mon-yy. For example, 12-aug-55 for 12th August, 1955.

1. SQL Data Definition and Data Types: Attribute Data Types and Domains in SQL

- 6. Additional data types
  - **i. Timestamp** data type which Includes the `DATE` and `TIME` fields
    - Plus a minimum of six positions for decimal fractions of seconds
    - Optional `WITH TIME ZONE` qualifier
    - Eg. TIMESTAMP ‘2014-09-27 09:12:47.648302’
  - **ii. INTERVAL** data type
    - Specifies a relative value that can be used to increment or decrement an absolute value of a date, time, or timestamp
  - **DATE, TIME, Timestamp, INTERVAL** data types can be **cast** or converted to string formats for comparison.

1. SQL Data Definition and Data Types: Attribute Data Types and Domains in SQL

- **Create Domain statement**
  - can be used to declare the data type of an attribute as SSN_TYPE
  - Example:
    - `CREATE DOMAIN SSN_TYPE AS CHAR(9);`
  - It makes it easier to change the data type for a domain that is used by numerous attributes
  - And use of domain improves schema readability
- **Create TYPE command can be used to create** User Defined Types (UDTs).

2. Specifying Constraints in SQL

Basic constraints:

- Relational Model has 3 basic constraint types that are supported in SQL:
  - **1. Key** constraint: A primary key value cannot be duplicated
  - **2. Entity Integrity** Constraint: A primary key value cannot be null
  - **3. Referential integrity** constraints : The “foreign key “ must have a value that is already present as a primary key, or may be null.

2. Specifying Constraints in SQL

Other 3 Restrictions on attribute domains are:

- 4. Default value of an attribute
  - **DEFAULT** `<value>`
- 5. NULL is not permitted for a particular attribute (NOT NULL)
- **6. CHECK** clause for restricting attribute or domain values at declaration of attribute
  - `Dnumber INT NOT NULL CHECK (Dnumber > 0 AND Dnumber < 21);`
  - An example `CHECK` clauses at the end of a `CREATE TABLE` statement
  - `CHECK (Dept_create_date <= Mgr_start_date);`

2. Specifying Constraints in SQL

- 1. Specifying Key and Referential Integrity Constraints
- **`i. PRIMARY KEY`** clause
  - Specifies one or more attributes that make up the primary key of a relation, e.g.,
  - `Dnumber INT PRIMARY KEY;`
- **`ii. UNIQUE`** clause
  - Specifies alternate (secondary) keys (called CANDIDATE keys in the relational model), e.g.,.
  - `Dname VARCHAR(15) UNIQUE;`

2. Specifying Constraints in SQL

- **2. ENTITY integrity is enforced from PRIMARY KEY clause although the NOT NULL can still be specified.**
- 3. **FOREIGN KEY** clause
  - Default operation: reject update on violation
  - Attach **referential triggered action** clause
    - Options include SET NULL, CASCADE, and SET DEFAULT
    - Action taken by the DBMS for SET NULL or SET DEFAULT is the same for both ON DELETE and ON UPDATE
    - CASCADE option suitable for "relationship" relations

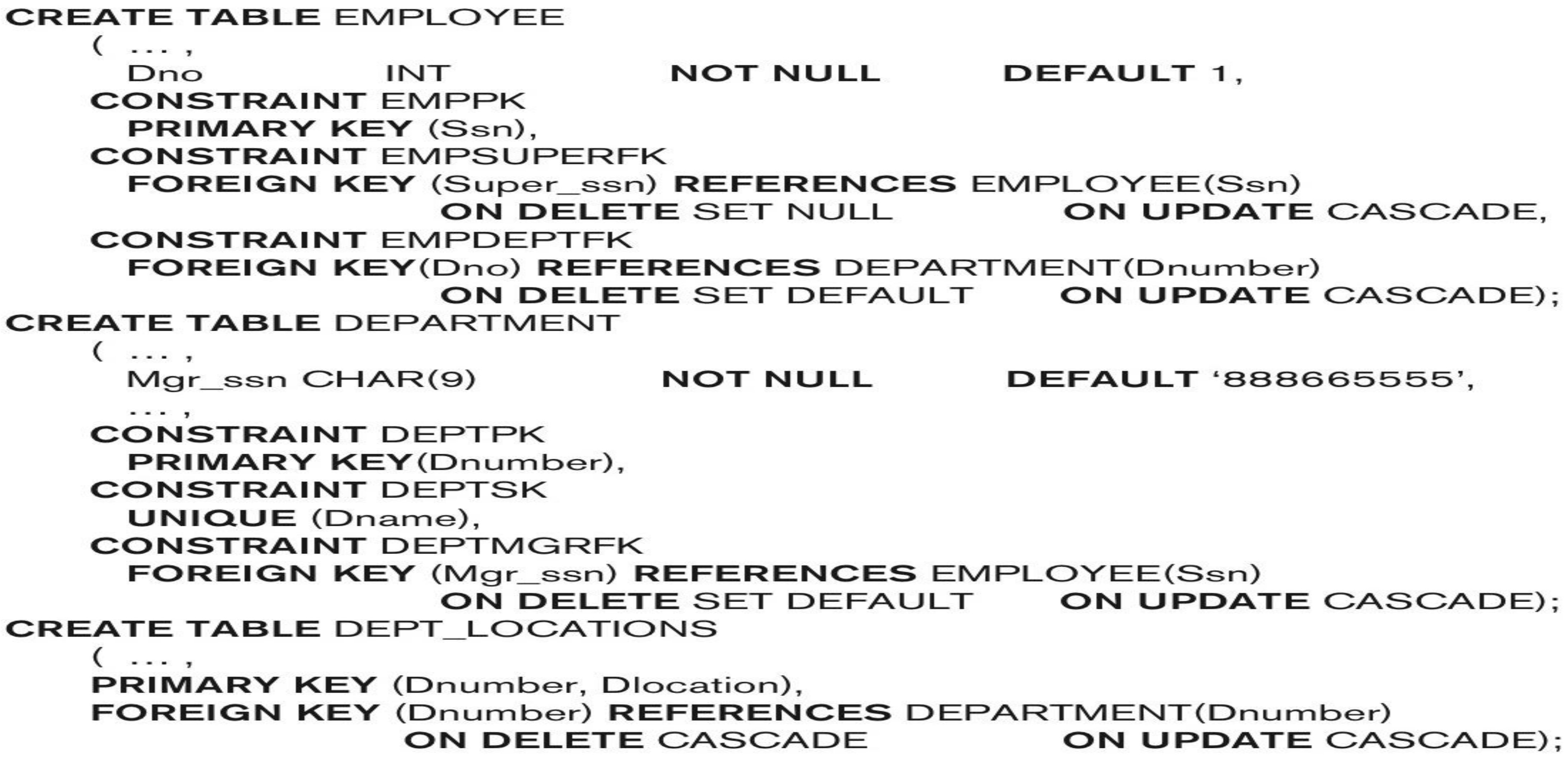
2. Specifying Constraints in SQL

- Giving Names to Constraints
  - Using the Keyword **CONSTRAINT**
    - a constraint can be named for easy later reference and use
  - **Fig 6.1 and 6.2 given next show some example uses of these constraints while creating tables.**

2. Specifying Constraints in SQL: **Figure 6.1 (continued)** SQL CREATE TABLE data definition statements for defining the COMPANY schema from Figure 5.7.

```
CREATE TABLE PROJECT
        ( Pname                         VARCHAR(15)                 NOT NULL,
          Pnumber                       INT                         NOT NULL,
          Plocation                     VARCHAR(15),
          Dnum                          INT                         NOT NULL,
        PRIMARY KEY (Pnumber),
        UNIQUE (Pname),
        FOREIGN KEY (Dnum) REFERENCES DEPARTMENT(Dnumber) );
CREATE TABLE WORKS_ON
        ( Essn                          CHAR(9)                     NOT NULL,
          Pno                           INT                         NOT NULL,
          Hours                         DECIMAL(3,1)                NOT NULL,
        PRIMARY KEY (Essn, Pno),
        FOREIGN KEY (Essn) REFERENCES EMPLOYEE(Ssn),
        FOREIGN KEY (Pno) REFERENCES PROJECT(Pnumber) );
CREATE TABLE DEPENDENT
        ( Essn                          CHAR(9)                     NOT NULL,
          Dependent_name                VARCHAR(15)                 NOT NULL,
          Sex                           CHAR,
          Bdate                         DATE,
          Relationship                  VARCHAR(8),
        PRIMARY KEY (Essn, Dependent_name),
        FOREIGN KEY (Essn) REFERENCES EMPLOYEE(Ssn) );
```

2. Specifying Constraints in SQL: Figure 6.2 Example illustrating how default attribute values and referential integrity triggered actions are specified in SQL.



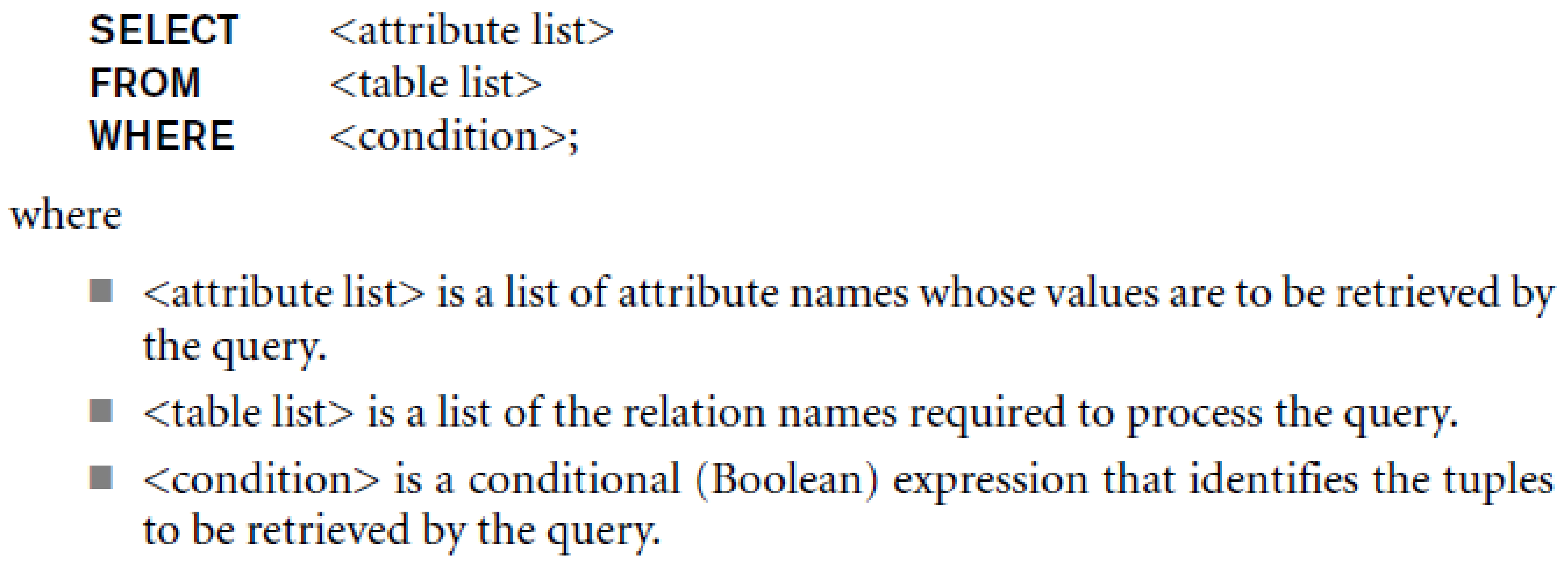
```
CREATE TABLE EMPLOYEE
       ( ... ,
         Dno          INT                NOT NULL        DEFAULT 1,
       CONSTRAINT EMPPK
         PRIMARY KEY (Ssn),
       CONSTRAINT EMPSUPERFK
         FOREIGN KEY (Super_ssn) REFERENCES EMPLOYEE(Ssn)
                        ON DELETE SET NULL          ON UPDATE CASCADE,
       CONSTRAINT EMPDEPTFK
         FOREIGN KEY(Dno) REFERENCES DEPARTMENT(Dnumber)
                        ON DELETE SET DEFAULT       ON UPDATE CASCADE);
CREATE TABLE DEPARTMENT
       ( ... ,
         Mgr_ssn CHAR(9)                 NOT NULL        DEFAULT '888665555',
         ... ,
       CONSTRAINT DEPTPK
         PRIMARY KEY(Dnumber),
       CONSTRAINT DEPTSK
         UNIQUE (Dname),
       CONSTRAINT DEPTMGRFK
         FOREIGN KEY (Mgr_ssn) REFERENCES EMPLOYEE(Ssn)
                        ON DELETE SET DEFAULT       ON UPDATE CASCADE);
CREATE TABLE DEPT_LOCATIONS
       ( ... ,
       PRIMARY KEY (Dnumber, Dlocation),
       FOREIGN KEY (Dnumber) REFERENCES DEPARTMENT(Dnumber)
                      ON DELETE CASCADE             ON UPDATE CASCADE);
```

3. Basic Retrieval Queries in SQL

- `SELECT` statement
  - Is one basic statement for retrieving information from a database
- SQL allows a table to have two or more tuples that are identical in all their attribute values
  - Unlike relational model (relational model which is strictly set-theory based and a set does not allow duplicate elements)
  - In SQL Multiset or bag behavior is possible
  - Tuple-id may be used as a key to enforce tuple uniqueness although this cannot be guaranteed in retrieved results.

3. Basic Retrieval Queries in SQL: The SELECT-FROM-WHERE Structure of Basic SQL Queries

- Basic form of the `SELECT` statement:



```
SELECT    <attribute list>
FROM      <table list>
WHERE     <condition>;
```

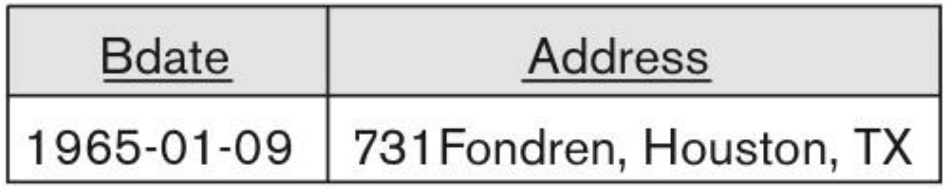
where

- <attribute list> is a list of attribute names whose values are to be retrieved by the query.
- <table list> is a list of the relation names required to process the query.
- <condition> is a conditional (Boolean) expression that identifies the tuples to be retrieved by the query.

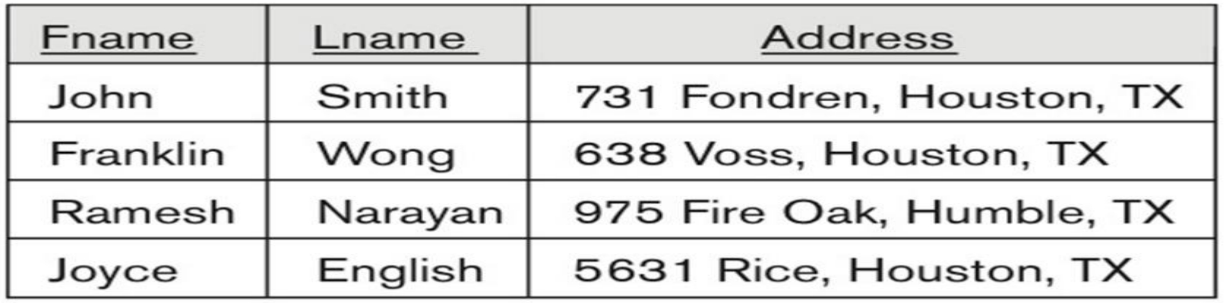
3. Basic Retrieval Queries in SQL: The SELECT-FROM-WHERE Structure of Basic SQL Queries

- Logical comparison operators are:
  - `=, <, <=, >, >=,` and `<> (not equal)`
- **Projection attributes are:**
  - Attributes whose values are to be retrieved
- **Selection condition is:**
  - Boolean condition that must be true for any retrieved tuple. Selection conditions include join conditions when multiple relations are involved.
  - A Boolean condition (expression) can be a literal value, an attribute value, or an expression or a conjunction (AND), disjunction (OR), or negation (NOT) of an expression.

Basic Retrieval Queries



Bdate	Address
1965-01-09	731 Fondren, Houston, TX



Fname	Lname	Address
John	Smith	731 Fondren, Houston, TX
Franklin	Wong	638 Voss, Houston, TX
Ramesh	Narayan	975 Fire Oak, Humble, TX
Joyce	English	5631 Rice, Houston, TX

Query 0. Retrieve the birth date and address of the employee(s) whose name is 'John B. Smith'.

```
Q0:     SELECT    Bdate, Address
        FROM      EMPLOYEE
        WHERE     Fname='John' AND Minit='B' AND Lname='Smith';
```

Query 1. Retrieve the name and address of all employees who work for the 'Research' department.

```
Q1:     SELECT    Fname, Lname, Address
        FROM      EMPLOYEE, DEPARTMENT
        WHERE     Dname='Research' AND Dnumber=Dno;
```

Basic Retrieval Queries (Contd.)

(c)

Pnumber	Dnum	Lname	Address	Bdate
10	4	Wallace	291Berry, Bellaire, TX	1941-06-20
30	4	Wallace	291Berry, Bellaire, TX	1941-06-20

Query 2. For every project located in 'Stafford', list the project number, the controlling department number, and the department manager's last name, address, and birth date.

```
Q2:     SELECT   Pnumber, Dnum, Lname, Address, Bdate
        FROM     PROJECT, DEPARTMENT, EMPLOYEE
        WHERE    Dnum=Dnumber AND Mgr_ssn=Ssn AND
                 Plocation='Stafford';
```

Ambiguous Attribute Names

- A query that involves only selection and join conditions plus projection of attributes is called a select-project-join (spj) query.
- Same name can be used for two (or more) attributes in different relations
  - As long as the attributes are in different relations
  - Must **qualify** the attribute name with the relation name to prevent ambiguity as in Q1A below.

```
Q1A:    SELECT    Fname, EMPLOYEE.Name, Address
        FROM      EMPLOYEE, DEPARTMENT
        WHERE     DEPARTMENT.Name='Research' AND
                  DEPARTMENT.Dnumber=EMPLOYEE.Dnumber;
```

Aliasing, and Renaming

- **Aliases** or **tuple variables can be used to:**
  - Declare alternative relation names E and S to refer to the EMPLOYEE relation twice in a query:

Query 8. For each employee, retrieve the employee's first and last name and the first and last name of his or her immediate supervisor.

```
SELECT  E.Fname, E.Lname, S.Fname, S.Lname
FROM        EMPLOYEE AS E, EMPLOYEE AS S
WHERE E.Super_ssn=S.Ssn;
```

  - Recommended practice is to abbreviate names and to prefix same or similar attribute from multiple tables.

Aliasing,Renaming and Tuple Variables (contd.)

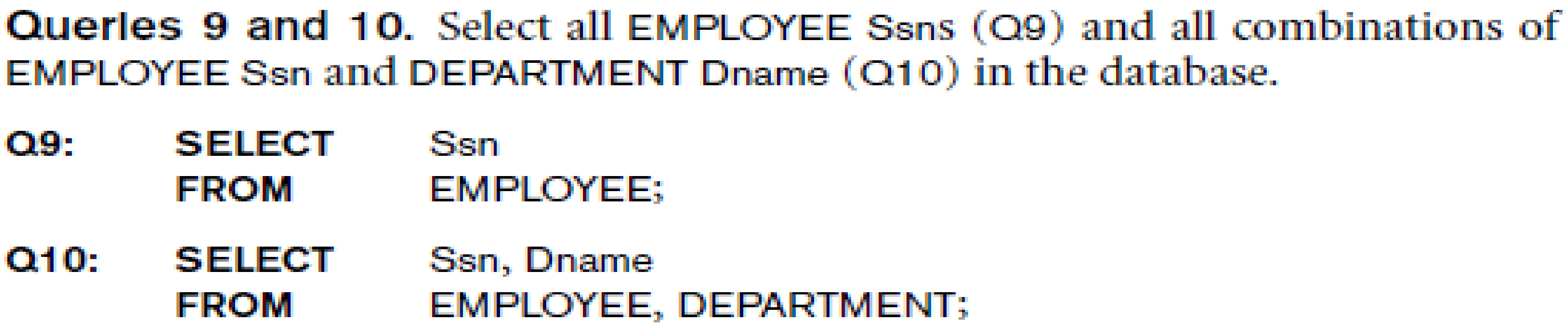
- The attribute names can also be renamed

```
EMPLOYEE AS E(Fn, Mi, Ln, Ssn, Bd, Addr, Sex,
Sal, Sssn, Dno)
```

- Note that the relation EMPLOYEE now has a variable name E which corresponds to a tuple variable
- The “AS” may be dropped in most SQL implementations

Unspecified WHERE Clause and Use of the Asterisk

- Missing `WHERE` clause
  - Indicates no condition on tuple selection
- Effect is a `CROSS PRODUCT`
  - Result is all possible tuple combinations (or the Algebra operation of Cartesian Product– see Ch.8) result



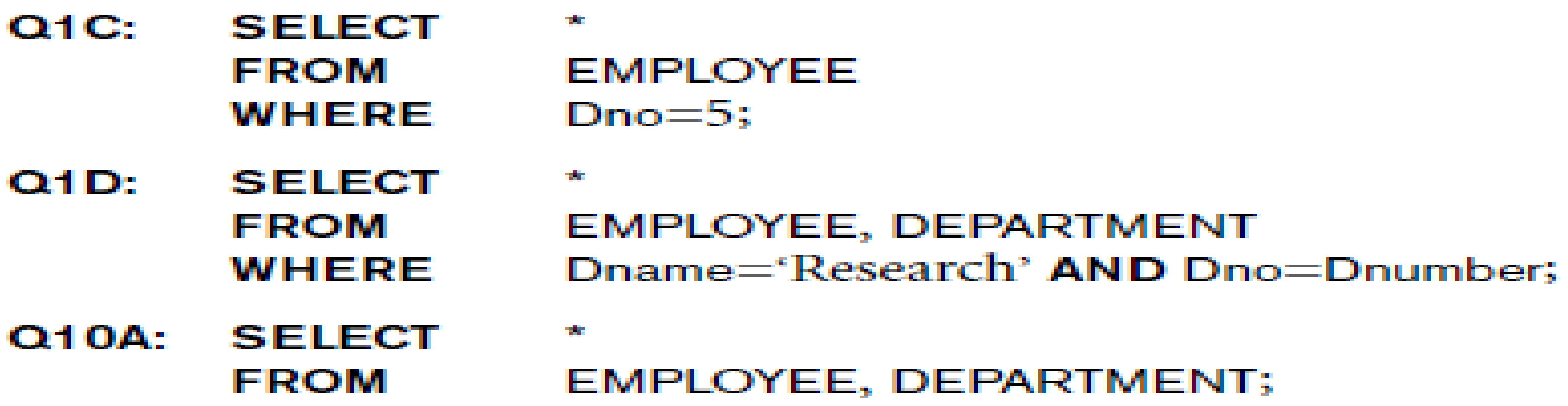
Queries 9 and 10. Select all EMPLOYEE Ssns (Q9) and all combinations of EMPLOYEE Ssn and DEPARTMENT Dname (Q10) in the database.

```
Q9:     SELECT    Ssn
        FROM      EMPLOYEE;

Q10:    SELECT    Ssn, Dname
        FROM      EMPLOYEE, DEPARTMENT;
```

Unspecified WHERE Clause and Use of the Asterisk (cont'd.)

- Specify an asterisk (*)
  - Retrieve all the attribute values of the selected tuples
  - The * can be prefixed by the relation name; e.g., EMPLOYEE . *



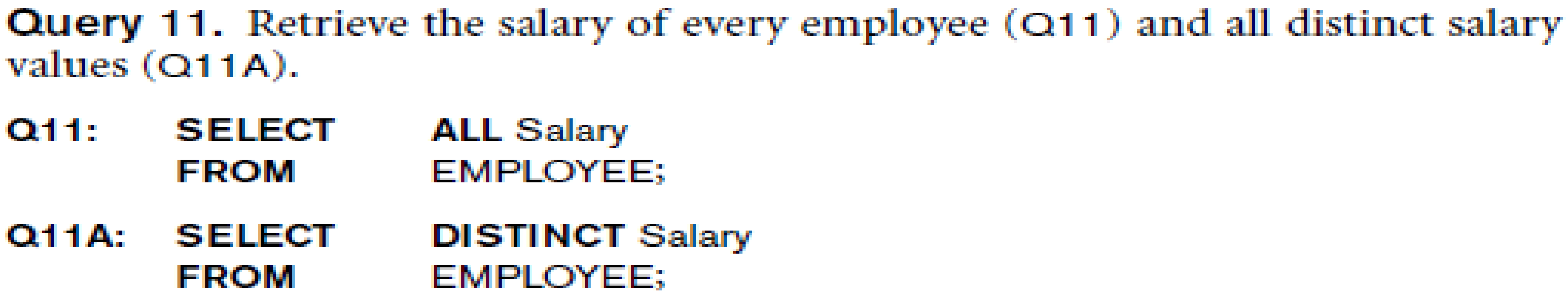
```
Q1C:    SELECT  *
        FROM    EMPLOYEE
        WHERE   Dno=5;

Q1D:    SELECT  *
        FROM    EMPLOYEE, DEPARTMENT
        WHERE   Dname='Research' AND Dno=Dnumber;

Q10A:   SELECT  *
        FROM    EMPLOYEE, DEPARTMENT;
```

Tables as Sets in SQL

- SQL does not automatically eliminate duplicate tuples in query results
- For aggregate operations (See sec 7.1.7) duplicates must be accounted for
- Use the keyword **DISTINCT** in the `SELECT` clause
  - Only distinct tuples should remain in the result



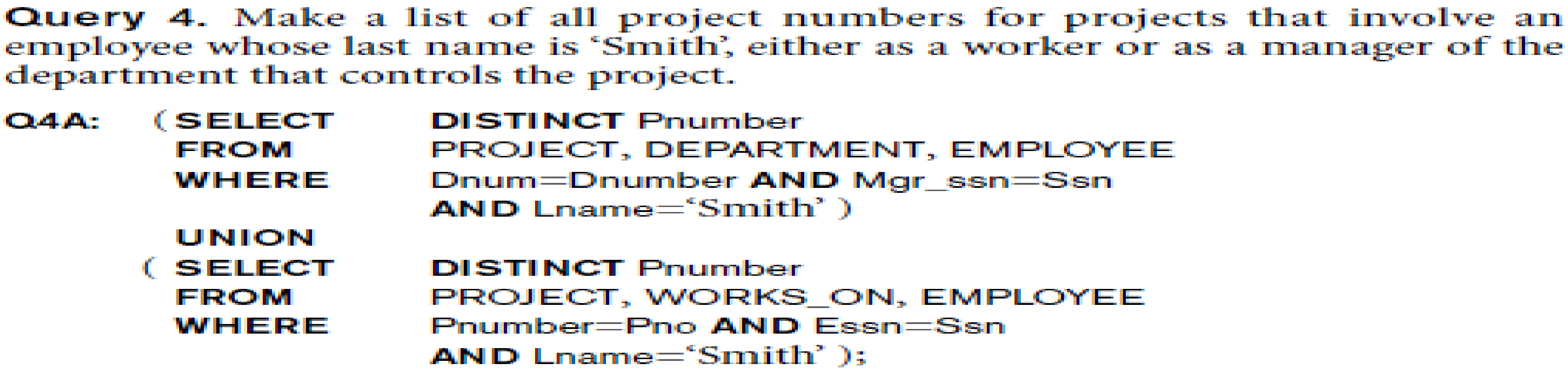
Query 11. Retrieve the salary of every employee (Q11) and all distinct salary values (Q11A).

```
Q11:    SELECT   ALL Salary
        FROM     EMPLOYEE;

Q11A:   SELECT   DISTINCT Salary
        FROM     EMPLOYEE;
```

Tables as Sets in SQL (cont'd.)

- Set operations
  - **UNION**, **EXCEPT** (difference), **INTERSECT**
  - Corresponding multiset operations: UNION ALL, EXCEPT ALL, INTERSECT ALL)
  - Type compatibility is needed for these operations to be valid



Query 4. Make a list of all project numbers for projects that involve an employee whose last name is 'Smith', either as a worker or as a manager of the department that controls the project.

```
Q4A:   ( SELECT    DISTINCT Pnumber
         FROM      PROJECT, DEPARTMENT, EMPLOYEE
         WHERE     Dnum=Dnumber AND Mgr_ssn=Ssn
                   AND Lname='Smith' )
         UNION
       ( SELECT    DISTINCT Pnumber
         FROM      PROJECT, WORKS_ON, EMPLOYEE
         WHERE     Pnumber=Pno AND Essn=Ssn
                   AND Lname='Smith' );
```

Substring Pattern Matching and Arithmetic Operators

- **LIKE** comparison operator is
  - Used for string **pattern matching**
  - % replaces an arbitrary number of zero or more characters
  - underscore (_) replaces a single character
  - Examples: **WHERE** Address **LIKE** ‘%Houston,TX%’;
  - **WHERE** Ssn **LIKE** ‘_ _ 1_ _ 8901’;
- **BETWEEN** comparison operator

E.g., in Q14 : Retrieve all employees in dept 5 whose salary is between $30,000 and $40,000.

SELECT * FROM EMPLOYEE

WHERE(Salary **BETWEEN** 30000 **AND** 40000)

AND Dno = 5;

Arithmetic Operations

- Standard arithmetic operators:
  - Addition (+), subtraction (–), multiplication (*), and division (/) may be included as a part of **SELECT clause**

- **Query 13.** Show the resulting salaries if every employee working on the ‘ProductX’ project is given a 10 percent raise.

```
SELECT  E.Fname, E.Lname, 1.1 * E.Salary AS Increased_sal
FROM  EMPLOYEE AS E, WORKS_ON AS W, PROJECT AS P
WHERE  E.Ssn=W.Essn AND W.Pno=P.Pnumber AND P.Pname=‘ProductX’;
```

Ordering of Query Results

- Use **ORDER BY** clause
  - Keyword **DESC** to see result in a descending order of values
  - Keyword **ASC** to specify ascending order explicitly
  - Typically placed at the end of the query

```
ORDER BY D.Dname DESC, E.Lname ASC, E.Fname ASC
```

Basic SQL Retrieval Query Block

```
SELECT          <attribute list>
FROM            <table list>
[ WHERE         <condition> ]
[ ORDER BY <attribute list> ];
```

4. INSERT, DELETE, and UPDATE Statements in SQL

- Three commands used to modify the database:
  - INSERT, DELETE, and UPDATE
- INSERT typically inserts a tuple (row) in a relation (table)
- UPDATE may update a number of tuples (rows) in a relation (table) that satisfy the condition
- DELETE may also update a number of tuples (rows) in a relation (table) that satisfy the condition

INSERT

- In its simplest form, it is used to add one or more tuples to a relation
- Attribute values should be listed in the same order as the attributes were specified in the **CREATE TABLE** command
- Constraints on data types are observed automatically
- Any integrity constraints as a part of the DDL specification are enforced

The INSERT Command

- Specify the relation name and a list of values for the tuple. All values including nulls are supplied.

```
U1:     INSERT INTO     EMPLOYEE
        VALUES          ( ‘Richard’, ‘K’, ‘Marini’, ‘653298653’, ‘1962-12-30’, ‘98
                          Oak Forest, Katy, TX’, ‘M’, 37000, ‘653298653’, 4 );
```

- The variation below inserts multiple tuples where a new table is loaded values from the result of a query.

```
U3B:    INSERT INTO     WORKS_ON_INFO ( Emp_name, Proj_name,
                        Hours_per_week )
        SELECT          E.Lname, P.Pname, W.Hours
        FROM            PROJECT P, WORKS_ON W, EMPLOYEE E
        WHERE           P.Pnumber=W.Pno AND W.Essn=E.Ssn;
```

BULK LOADING OF TABLES

- Another variation of **INSERT** is used for bulk-loading of several tuples into tables
- A new table TNEW can be created with the same attributes as T and using LIKE and DATA in the syntax, it can be loaded with entire data.
- EXAMPLE

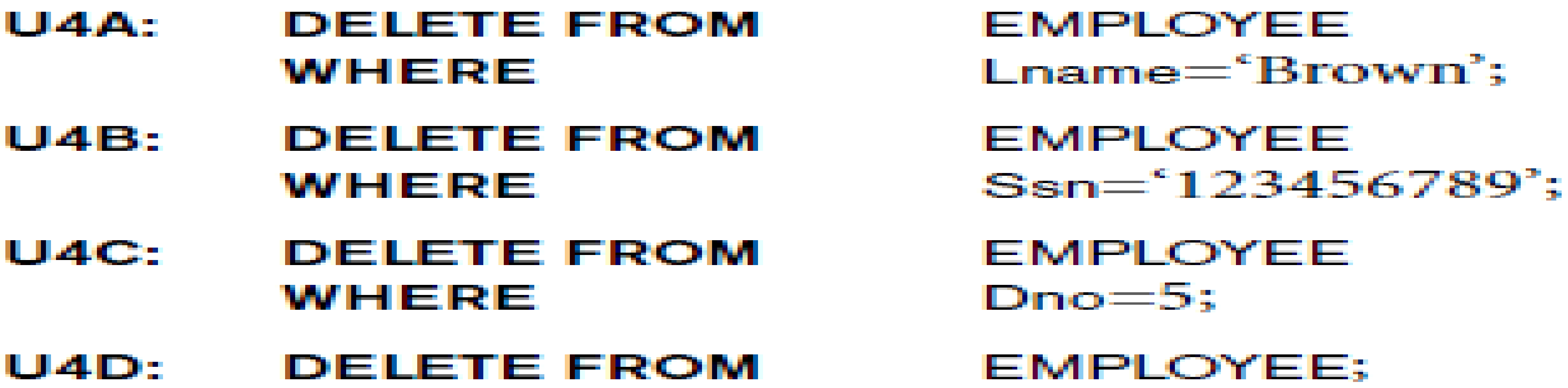
```
CREATE TABLE D5EMPS  LIKE  EMPLOYEE
                    (SELECT   E.*
                     FROM       EMPLOYEE AS E
                    WHERE     E.Dno=5)
 WITH DATA;
```

DELETE

- Removes tuples from a relation
  - Includes a WHERE-clause to select the tuples to be deleted
  - Referential integrity should be enforced
  - Tuples are deleted from only *one table* at a time (unless CASCADE is specified on a referential integrity constraint)
  - A missing WHERE-clause specifies that *all tuples* in the relation are to be deleted; the table then becomes an empty table
  - The number of tuples deleted depends on the number of tuples in the relation that satisfy the WHERE-clause

The DELETE Command

- Removes tuples from a relation
  - Includes a `WHERE` clause to select the tuples to be deleted. The number of tuples deleted will vary.



```
U4A:    DELETE FROM    EMPLOYEE
        WHERE          Lname='Brown';
U4B:    DELETE FROM    EMPLOYEE
        WHERE          Ssn='123456789';
U4C:    DELETE FROM    EMPLOYEE
        WHERE          Dno=5;
U4D:    DELETE FROM    EMPLOYEE;
```

UPDATE

- Used to modify attribute values of one or more selected tuples
- A WHERE-clause selects the tuples to be modified
- An additional SET-clause specifies the attributes to be modified and their new values
- Each command modifies tuples *in the same relation*
- Referential integrity specified as part of DDL specification is enforced

UPDATE (contd.)

- Example: Change the location and controlling department number of project number 10 to 'Bellaire' and 5, respectively

```
U5:     UPDATE    PROJECT
        SET       PLOCATION = 'Bellaire',
        DNUM = 5
        WHERE     PNUMBER=10
```

UPDATE (contd.)

- Example: Give all employees in the 'Research' department a 10% raise in salary.

```
U6: UPDATE    EMPLOYEE
    SET       SALARY = SALARY *1.1
    WHERE     DNO  IN (SELECT    DNUMBER
                  FROM        DEPARTMENT
                  WHERE       DNAME='Research')
```

- In this request, the modified SALARY value depends on the original SALARY value in each tuple
  - The reference to the SALARY attribute on the right of = refers to the old SALARY value before modification
  - The reference to the SALARY attribute on the left of = refers to the new SALARY value after modification

Fig. 6.4: Results of Queries Q11, Q11A, Q16 and Q18

(a)

Salary
30000
40000
25000
43000
38000
25000
25000
55000

(b)

Salary
30000
40000
25000
43000
38000
55000

(c)

Fname	Lname

(d)

Fname	Lname
James	Borg

Figure 6.4 Results of additional SQL queries when applied to the COMPANY database state shown in Figure 5.6. (a) Q11. (b) Q11A. (c) Q16. (d) Q18.