

# Database Systems: Design, Implementation, and Management

## *Lesson 7*

# Objectives

In this chapter, students will learn:

- ▶ The basic commands and functions of SQL
- ▶ How to use SQL for data administration (to create tables and indexes)
- ▶ How to use SQL for data manipulation (to add, modify, delete, and retrieve data)
- ▶ How to use SQL to query a database for useful information

# Introduction to SQL

- ▶ SQL functions fit into two broad categories:
  - Data definition language
  - Data manipulation language
- ▶ Basic command set has vocabulary of fewer than 100 words
- ▶ American National Standards Institute (ANSI) prescribes a standard SQL
- ▶ Several SQL dialects exist

**TABLE  
7.1**

## SQL Data Definition Commands

COMMAND OR OPTION	DESCRIPTION
CREATE SCHEMA AUTHORIZATION	Creates a database schema
CREATE TABLE	Creates a new table in the user's database schema
NOT NULL	Ensures that a column will not have null values
UNIQUE	Ensures that a column will not have duplicate values
PRIMARY KEY	Defines a primary key for a table
FOREIGN KEY	Defines a foreign key for a table
DEFAULT	Defines a default value for a column (when no value is given)
CHECK	Validates data in an attribute
CREATE INDEX	Creates an index for a table
CREATE VIEW	Creates a dynamic subset of rows and columns from one or more tables (see Chapter 8, Advanced SQL)
ALTER TABLE	Modifies a table's definition (adds, modifies, or deletes attributes or constraints)
CREATE TABLE AS	Creates a new table based on a query in the user's database schema
DROP TABLE	Permanently deletes a table (and its data)
DROP INDEX	Permanently deletes an index
DROP VIEW	Permanently deletes a view

**TABLE**  
**7.2**

## SQL Data Manipulation Commands

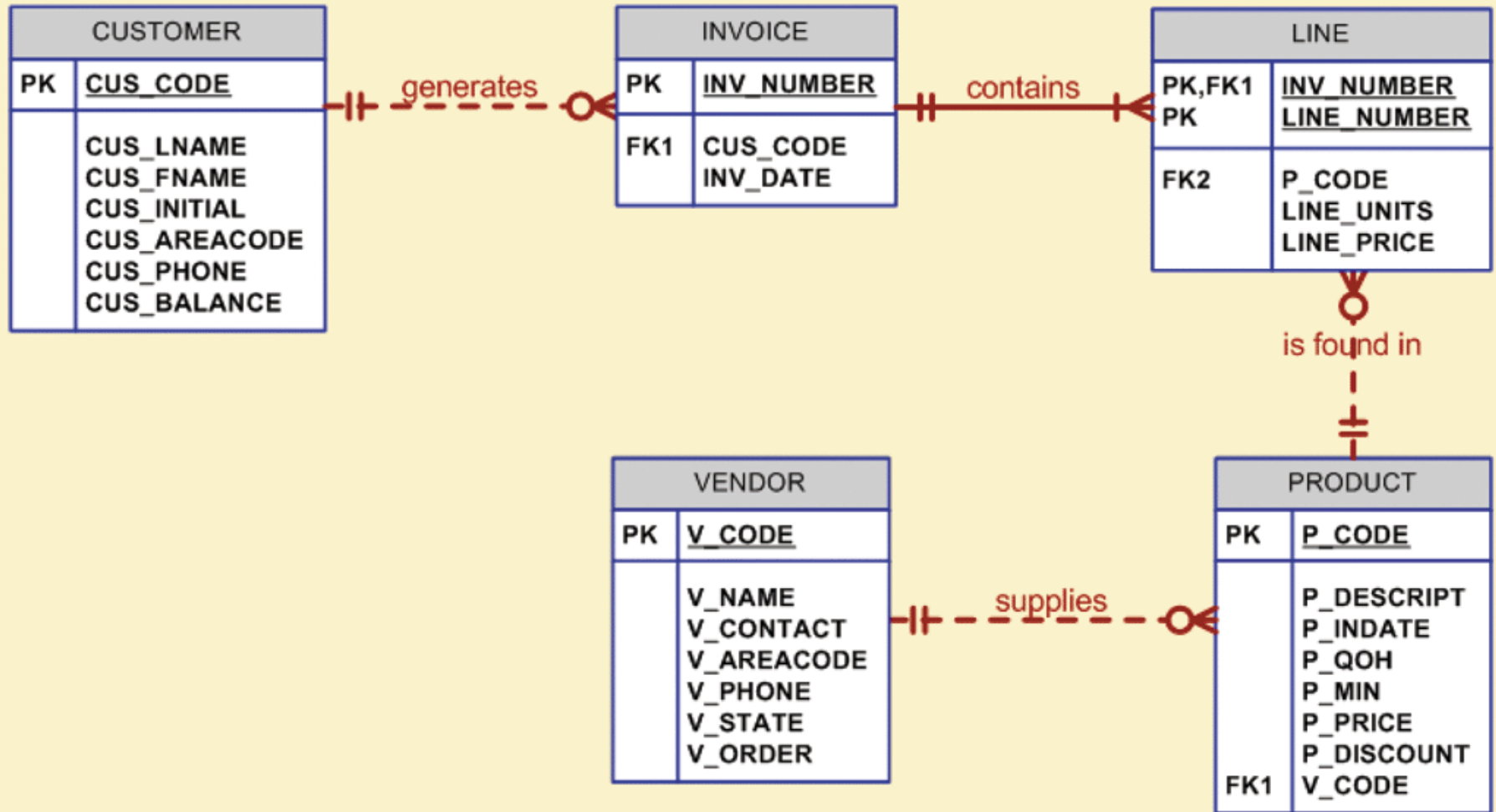
COMMAND OR OPTION	DESCRIPTION
INSERT	Inserts row(s) into a table
SELECT	Selects attributes from rows in one or more tables or views
WHERE	Restricts the selection of rows based on a conditional expression
GROUP BY	Groups the selected rows based on one or more attributes
HAVING	Restricts the selection of grouped rows based on a condition
ORDER BY	Orders the selected rows based on one or more attributes
UPDATE	Modifies an attribute's values in one or more table's rows
DELETE	Deletes one or more rows from a table
COMMIT	Permanently saves data changes
ROLLBACK	Restores data to their original values
<b>Comparison operators</b>	
=, <, >, <=, >=, <>	Used in conditional expressions
<b>Logical operators</b>	
AND/OR/NOT	Used in conditional expressions
<b>Special operators</b>	Used in conditional expressions
BETWEEN	Checks whether an attribute value is within a range
IS NULL	Checks whether an attribute value is null
LIKE	Checks whether an attribute value matches a given string pattern
IN	Checks whether an attribute value matches any value within a value list
EXISTS	Checks whether a subquery returns any rows
DISTINCT	Limits values to unique values
<b>Aggregate functions</b>	Used with SELECT to return mathematical summaries on columns
COUNT	Returns the number of rows with non-null values for a given column
MIN	Returns the minimum attribute value found in a given column
MAX	Returns the maximum attribute value found in a given column
SUM	Returns the sum of all values for a given column
AVG	Returns the average of all values for a given column

# Data Definition Commands

- ▶ The database model
  - In this lesson, a simple database with these tables is used to illustrate commands:
    - CUSTOMER
    - INVOICE
    - LINE
    - PRODUCT
    - VENDOR
  - Focus on PRODUCT and VENDOR tables

FIGURE  
7.1

## The database model



SOURCE: Course Technology/Cengage Learning



# Creating the Database

- ▶ Two tasks must be completed:
  - Create database structure
  - Create tables that will hold end-user data
- ▶ First task:
  - RDBMS creates physical files that will hold database
  - Differs substantially from one RDBMS to another



# Creating the Database (cont'd.)

## ▶ Authentication

- DBMS verifies that only registered users are able to access database
- Log on to RDBMS using user ID and password created by database administrator

# The Database Schema

- ▶ Schema
  - Group of database objects that are related to each other
- ▶ **CREATE SCHEMA AUTHORIZATION {creator};**
  - Command is seldom used directly

# Data Types

- ▶ Data type selection is usually dictated by nature of data and by intended use
- ▶ Supported data types:
  - Number(L,D), Integer, Smallint, Decimal(L,D)
  - Char(L), Varchar(L), Varchar2(L)
  - Date, Time, Timestamp
  - Real, Double, Float
  - Interval day to hour
  - Many other types

**TABLE  
7.3**

### Data Dictionary for the Ch07\_SaleCo Database

TABLE NAME	ATTRIBUTE NAME	CONTENTS	TYPE	FORMAT	RANGE*	REQUIRED	PK OR FK	FK REFERENCED TABLE
PRODUCT	P_CODE	Product code	VARCHAR(10)	XXXXXXXXXX	NA	Y	PK	
	P_DESCRIPT	Product description	VARCHAR(35)	XXXXXXXXXXXX	NA	Y		
	P_INDATE	Stocking date	DATE	DD-MON-YYYY	NA	Y		
	P_QOH	Units available	SMALLINT	####	0–9999	Y		
	P_MIN	Minimum units	SMALLINT	####	0–9999	Y		
	P_PRICE	Product price	NUMBER(8,2)	####.##	0.00–9999.00	Y		
	P_DISCOUNT	Discount rate	NUMBER(5,2)	0.##	0.00–0.20	Y		
	V_CODE	Vendor code	INTEGER	###	100–999		FK	VENDOR
VENDOR	V_CODE	Vendor code	INTEGER	####	1000–9999	Y	PK	
	V_NAME	Vendor name	VARCHAR(35)	XXXXXXXXXXXX	NA	Y		
	V_CONTACT	Contact person	VARCHAR(25)	XXXXXXXXXXXX	NA	Y		
	V_AREACODE	Area code	CHAR(3)	999	NA	Y		
	V_PHONE	Phone number	CHAR(8)	999–9999	NA	Y		
	V_STATE	State	CHAR(2)	XX	NA	Y		
	V_ORDER	Previous order	CHAR(1)	X	Y or N	Y		

**TABLE**  
**7.4**

## Some Common SQL Data Types

DATA TYPE	FORMAT	COMMENTS
<b>Numeric</b>	NUMBER(L,D)	The declaration NUMBER(7,2) indicates that numbers will be stored with two decimal places and may be up to seven digits long, including the sign and the decimal place (for example, 12.32 or -134.99).
	INTEGER	May be abbreviated as INT. Integers are (whole) counting numbers, so they cannot be used if you want to store numbers that require decimal places.
	SMALLINT	Like INTEGER but limited to integer values up to six digits. If your integer values are relatively small, use SMALLINT instead of INT.
	DECIMAL(L,D)	Like the NUMBER specification, but the storage length is a <i>minimum</i> specification. That is, greater lengths are acceptable, but smaller ones are not. DECIMAL(9,2), DECIMAL(9), and DECIMAL are all acceptable.
<b>Character</b>	CHAR(L)	Fixed-length character data for up to 255 characters. If you store strings that are not as long as the CHAR parameter value, the remaining spaces are left unused. Therefore, if you specify CHAR(25), strings such as <i>Smith</i> and <i>Katzenjammer</i> are each stored as 25 characters. However, a U.S. area code is always three digits long, so CHAR(3) would be appropriate if you wanted to store such codes.
	VARCHAR(L) or VARCHAR2(L)	Variable-length character data. The designation VARCHAR2(25) will let you store characters up to 25 characters long. However, VARCHAR will not leave unused spaces. Oracle automatically converts VARCHAR to VARCHAR2.
<b>Date</b>	DATE	Stores dates in the Julian date format.

# Creating Table Structures

- ▶ Use one line per column (attribute) definition
- ▶ Use spaces to line up attribute characteristics and constraints
- ▶ Table and attribute names are capitalized
- ▶ NOT NULL specification
- ▶ UNIQUE specification

# Creating Table Structures (cont'd.)

- ▶ Primary key attributes contain both a NOT NULL and a UNIQUE specification
- ▶ RDBMS will automatically enforce referential integrity for foreign keys
- ▶ Command sequence ends with semicolon



# SQL Constraints

- ▶ NOT NULL constraint
  - Ensures that column does not accept nulls
- ▶ UNIQUE constraint
  - Ensures that all values in column are unique
- ▶ DEFAULT constraint
  - Assigns value to attribute when a new row is added to table
- ▶ CHECK constraint
  - Validates data when attribute value is entered

# SQL Indexes

- ▶ When primary key is declared, DBMS automatically creates unique index
- ▶ Often need additional indexes
- ▶ Using CREATE INDEX command, SQL indexes can be created on basis of any selected attribute
- ▶ Composite index
  - Index based on two or more attributes
  - Often used to prevent data duplication

# Data Manipulation Commands

- ▶ INSERT
- ▶ SELECT
- ▶ UPDATE
- ▶ DELETE

# Adding Table Rows

## ▶ INSERT

- Used to enter data into table
- Syntax:
  - INSERT INTO columnname  
VALUES (value1, value2, ... , valueN);

# Adding Table Rows (cont'd.)

- ▶ When entering values, notice that:
  - Row contents are entered between parentheses
  - Character and date values are entered between apostrophes
  - Numerical entries are not enclosed in apostrophes
  - Attribute entries are separated by commas
  - A value is required for each column
- ▶ Use NULL for unknown values

# Saving Table Changes

- ▶ Changes made to table contents are not physically saved on disk until:
  - Database is closed
  - Program is closed
  - COMMIT command is used
- ▶ Syntax:
  - COMMIT [WORK];
- ▶ Will permanently save any changes made to any table in the database

# Listing Table Rows

- ▶ **SELECT**

- Used to list contents of table
- Syntax:

```
SELECT columnlist  
FROM tablename;
```

- ▶ Columnlist represents one or more attributes, separated by commas
- ▶ Asterisk can be used as wildcard character to list all attributes



# Updating Table Rows

## ▶ UPDATE

- Modify data in a table
- Syntax:

UPDATE tablename

SET columnname = expression [, columnname =  
expression]

[WHERE conditionlist];

- ▶ If more than one attribute is to be updated in row, separate corrections with commas

# Restoring Table Contents

- ▶ **ROLLBACK**
  - Undoes changes since last COMMIT
  - Brings data back to prechange values
- ▶ **Syntax:**  
    ROLLBACK;
- ▶ **COMMIT and ROLLBACK only work with commands to add, modify, or delete table rows**

# Deleting Table Rows

- ▶ **DELETE**

- Deletes a table row
- Syntax:

```
DELETE FROM tablename  
[WHERE conditionlist ];
```

- ▶ **WHERE condition is optional**
- ▶ **If WHERE condition is not specified, all rows from specified table will be deleted**

# Inserting Table Rows with a SELECT Subquery

## ▶ INSERT

- Inserts multiple rows from another table (source)
- Uses SELECT subquery
- Subquery: query embedded (or nested or inner) inside another query
- Subquery executed first
- Syntax:

```
INSERT INTO tablename SELECT columnlist FROM  
tablename;
```

# SELECT Queries

- ▶ Fine-tune SELECT command by adding restrictions to search criteria using:
  - Conditional restrictions
  - Arithmetic operators
  - Logical operators
  - Special operators

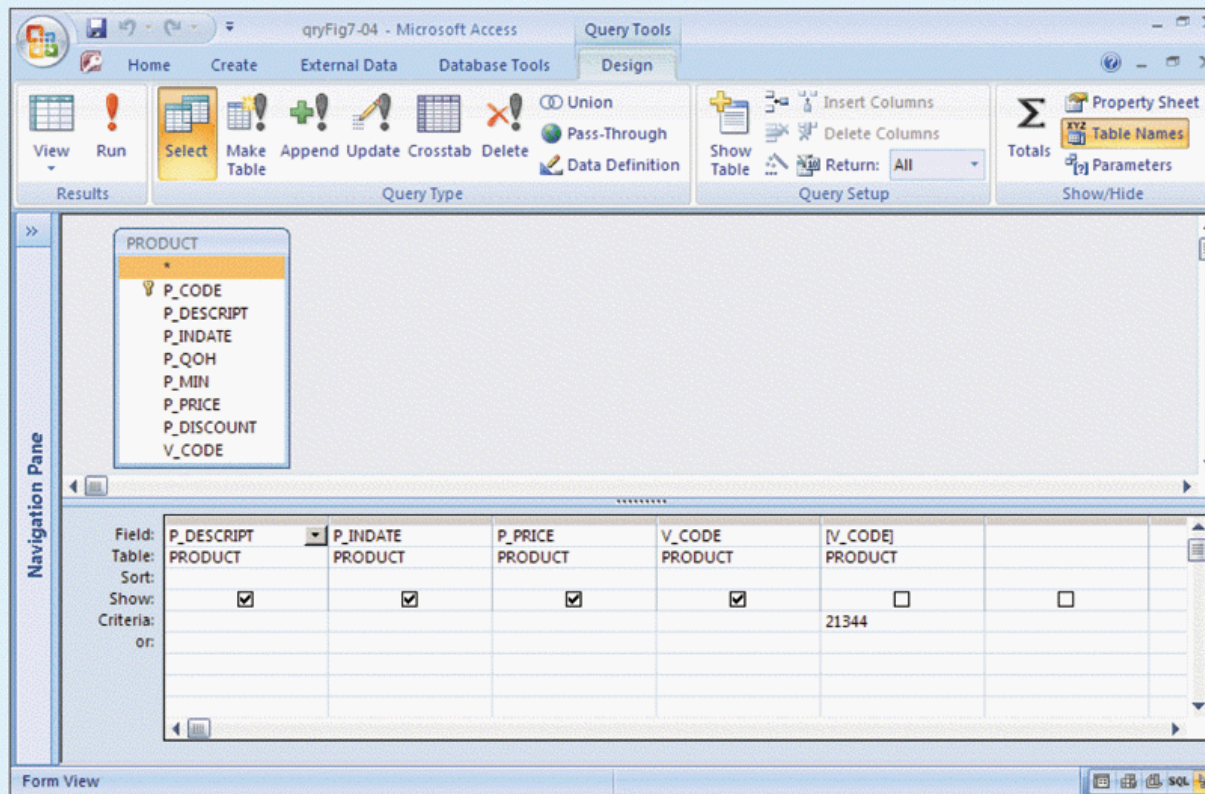
# Selecting Rows with Conditional Restrictions

- ▶ Select partial table contents by placing restrictions on rows to be included in output
  - Add conditional restrictions to SELECT statement, using WHERE clause
- ▶ Syntax:  
SELECT columnlist  
FROM tablelist  
[ WHERE conditionlist ] ;

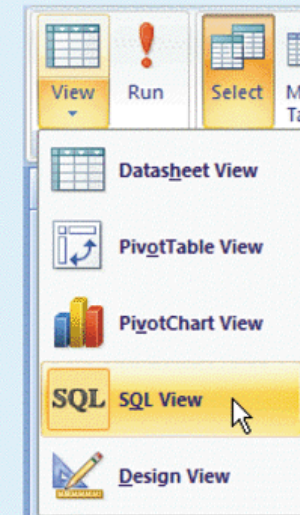


**FIGURE 7.5**

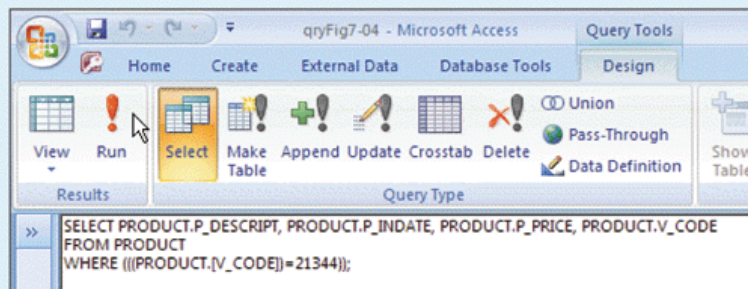
## The Microsoft Access QBE and its SQL



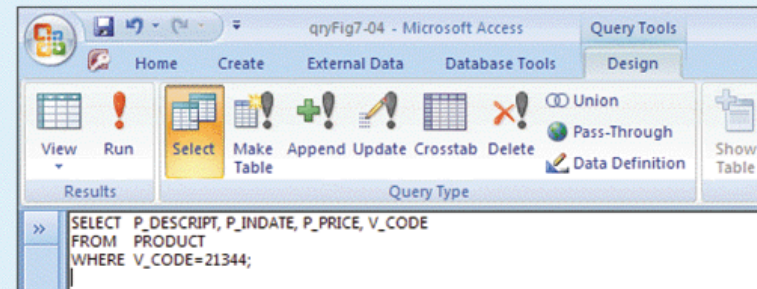
### Query view options



### Microsoft Access-generated SQL



### User-entered SQL



SOURCE: Course Technology/Cengage Learning



**TABLE  
7.6**

## Comparison Operators

SYMBOL	MEANING
=	Equal to
<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
<> or !=	Not equal to

# Selecting Rows with Conditional Restrictions (cont'd.)

- ▶ Using comparison operators on dates
  - Date procedures are often more software-specific than other SQL procedures
- ▶ Using computed columns and column aliases
  - SQL accepts any valid expressions (or formulas) in the computed columns
  - Alias
    - Alternate name given to a column or table in any SQL statement

# Arithmetic Operators:

## The Rule of Precedence

- ▶ Perform operations within parentheses
- ▶ Perform power operations
- ▶ Perform multiplications and divisions
- ▶ Perform additions and subtractions

**TABLE**  
**7.7**

**The Arithmetic Operators**

ARITHMETIC OPERATOR	DESCRIPTION
+	Add
-	Subtract
*	Multiply
/	Divide
^	Raise to the power of (some applications use ** instead of ^)

# Logical Operators: AND, OR, and NOT

- ▶ Searching data involves multiple conditions
- ▶ Logical operators: AND, OR, and NOT
- ▶ Can be combined
  - Parentheses enforce precedence order
    - Conditions in parentheses are always executed first
- ▶ Boolean algebra: mathematical field dedicated to use of logical operators
- ▶ NOT negates result of conditional expression

# Special Operators

- ▶ BETWEEN: checks whether attribute value is within a range
- ▶ IS NULL: checks whether attribute value is null
- ▶ LIKE: checks whether attribute value matches given string pattern
- ▶ IN: checks whether attribute value matches any value within a value list
- ▶ EXISTS: checks if subquery returns any rows

# Advanced Data Definition Commands

- ▶ All changes in table structure are made by using ALTER command
- ▶ Three options:
  - ADD adds a column
  - MODIFY changes column characteristics
  - DROP deletes a column
- ▶ Can also be used to:
  - Add table constraints
  - Remove table constraints

# Changing a Column's Data Type

- ▶ ALTER can be used to change data type
- ▶ Some RDBMSs do not permit changes to data types unless column is empty



# Changing a Column's Data Characteristics

- ▶ Use ALTER to change data characteristics
- ▶ Changes in column's characteristics are permitted if changes do not alter the existing data type

# Adding a Column

## Dropping a Column

- ▶ Use ALTER to add column
  - Do not include the NOT NULL clause for new column
- ▶ Use ALTER to drop column
  - Some RDBMSs impose restrictions on the deletion of an attribute

# Advanced Data Updates

- ▶ UPDATE command updates only data in existing rows
- ▶ If relationship between entries and existing columns, can assign values to slots
- ▶ Arithmetic operators are useful in data updates

# Copying Parts of Tables

- ▶ SQL permits copying contents of selected table columns
  - Data need not be reentered manually into newly created table(s)
- ▶ First create the table structure
- ▶ Next add rows to new table using table rows from another table

# Adding Primary and Foreign Key Designations

- ▶ When table is copied, integrity rules do not copy
  - Primary and foreign keys are manually defined on new table
- ▶ User ALTER TABLE command
  - Syntax:
    - ALTER TABLE tablename ADD PRIMARY KEY(fieldname);
  - For foreign key, use FOREIGN KEY in place of PRIMARY KEY

# Deleting a Table from the Database

## ▶ DROP

- Deletes table from database
- Syntax:
  - DROP TABLE tablename;
- ▶ Can drop a table only if it is not the “one” side of any relationship
  - Otherwise, RDBMS generates an error message
  - Foreign key integrity violation

# Additional SELECT Query Keywords

- ▶ Logical operators work well in the query environment
- ▶ SQL provides useful functions that:
  - Count
  - Find minimum and maximum values
  - Calculate averages, etc.
- ▶ SQL allows user to limit queries to:
  - Entries having no duplicates
  - Entries whose duplicates may be grouped

# Ordering a Listing

- ▶ ORDER BY clause is useful when listing order is important
- ▶ Syntax:  
    SELECT columnlist  
    FROM tablelist  
    [WHERE conditionlist]  
    [ORDER BY columnlist [ASC | DESC]];
- ▶ Ascending order by default



# Listing Unique Values

- ▶ DISTINCT clause produces list of only values that are different from one another
- ▶ Example:  

```
SELECT DISTINCT V_CODE  
FROM   PRODUCT;
```
- ▶ Access places nulls at the top of the list
  - Oracle places it at the bottom
  - Placement of nulls does not affect list contents

# Aggregate Functions

- ▶ COUNT function tallies number of non-null values of an attribute
  - Takes one parameter: usually a column name
- ▶ MAX and MIN find highest (lowest) value in a table
  - Compute MAX value in inner query
  - Compare to each value returned by the query
- ▶ SUM computes total sum for any specified attribute
- ▶ AVG function format is similar to MIN and MAX

# Grouping Data

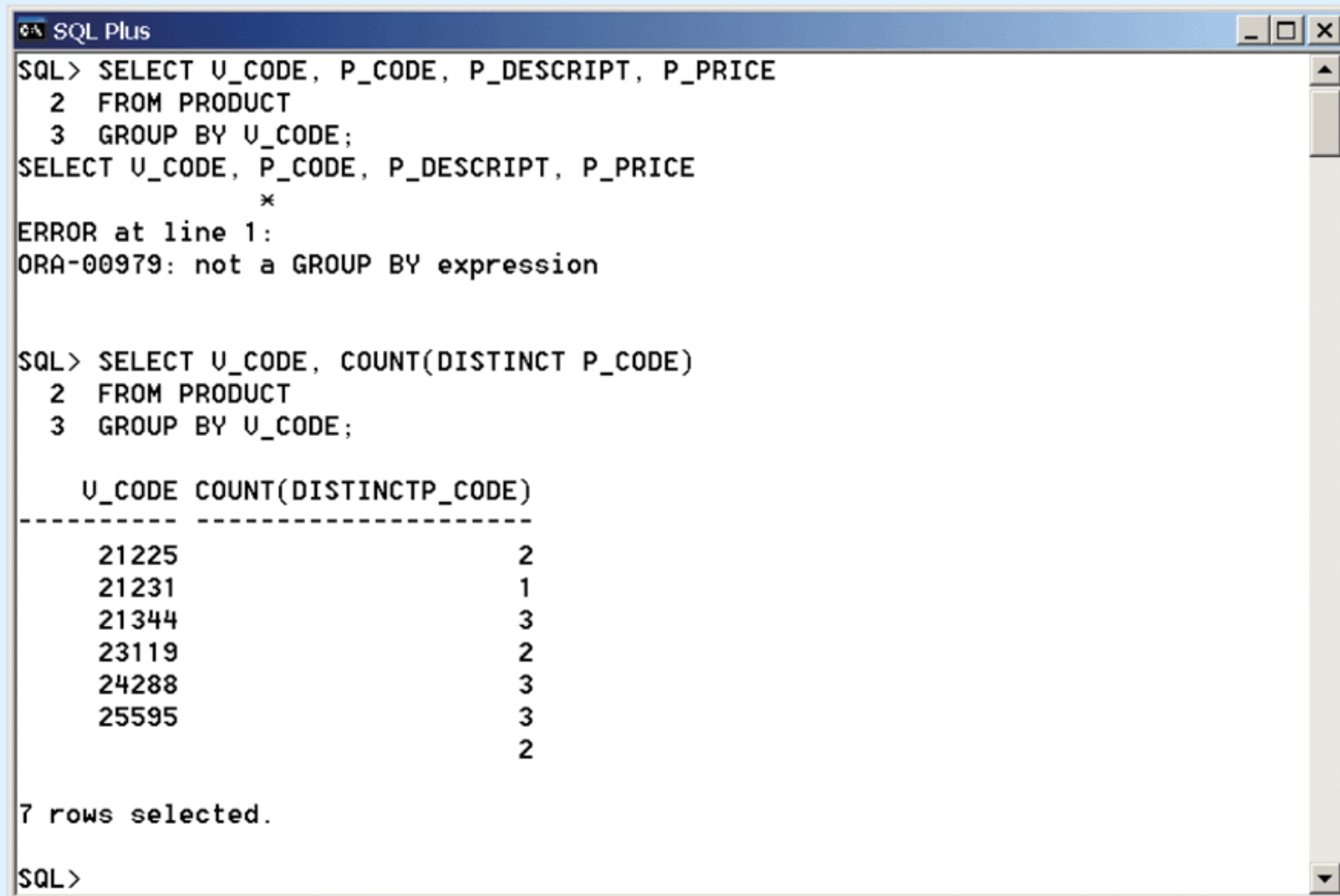
- ▶ Frequency distributions created by GROUP BY clause within SELECT statement

- ▶ Syntax:

```
SELECT columnlist  
FROM          tablelist  
[WHERE conditionlist]  
[GROUP BY     columnlist]  
[HAVING conditionlist]  
[ORDER BY     columnlist [ASC | DESC] ] ;
```

**FIGURE  
7.26**

## Incorrect and correct use of the GROUP BY clause



```
SQL> SELECT U_CODE, P_CODE, P_DESCRIPT, P_PRICE
2 FROM PRODUCT
3 GROUP BY U_CODE;
SELECT U_CODE, P_CODE, P_DESCRIPT, P_PRICE
      *
ERROR at line 1:
ORA-00979: not a GROUP BY expression

SQL> SELECT U_CODE, COUNT(DISTINCT P_CODE)
2 FROM PRODUCT
3 GROUP BY U_CODE;

  U_CODE COUNT(DISTINCT P_CODE)
-----
21225          2
21231          1
21344          3
23119          2
24288          3
25595          3
          2

7 rows selected.

SQL>
```

SOURCE: Course Technology/Cengage Learning

# Joining Database Tables

- ▶ Joining tables is the most important distinction between relational database and other DBs
- ▶ Join is performed when data are retrieved from more than one table at a time
  - Equality comparison between foreign key and primary key of related tables
- ▶ Join tables by listing tables in FROM clause of SELECT statement
  - DBMS creates Cartesian product of every table

# Joining Tables with an Alias

- ▶ Alias identifies the source table from which data are taken
- ▶ Alias can be used to identify source table
- ▶ Any legal table name can be used as alias
- ▶ Add alias after table name in FROM clause
  - FROM tablename alias