

## **Lab 2: Building a database: Table by Table**

The learning objectives of this lab are to

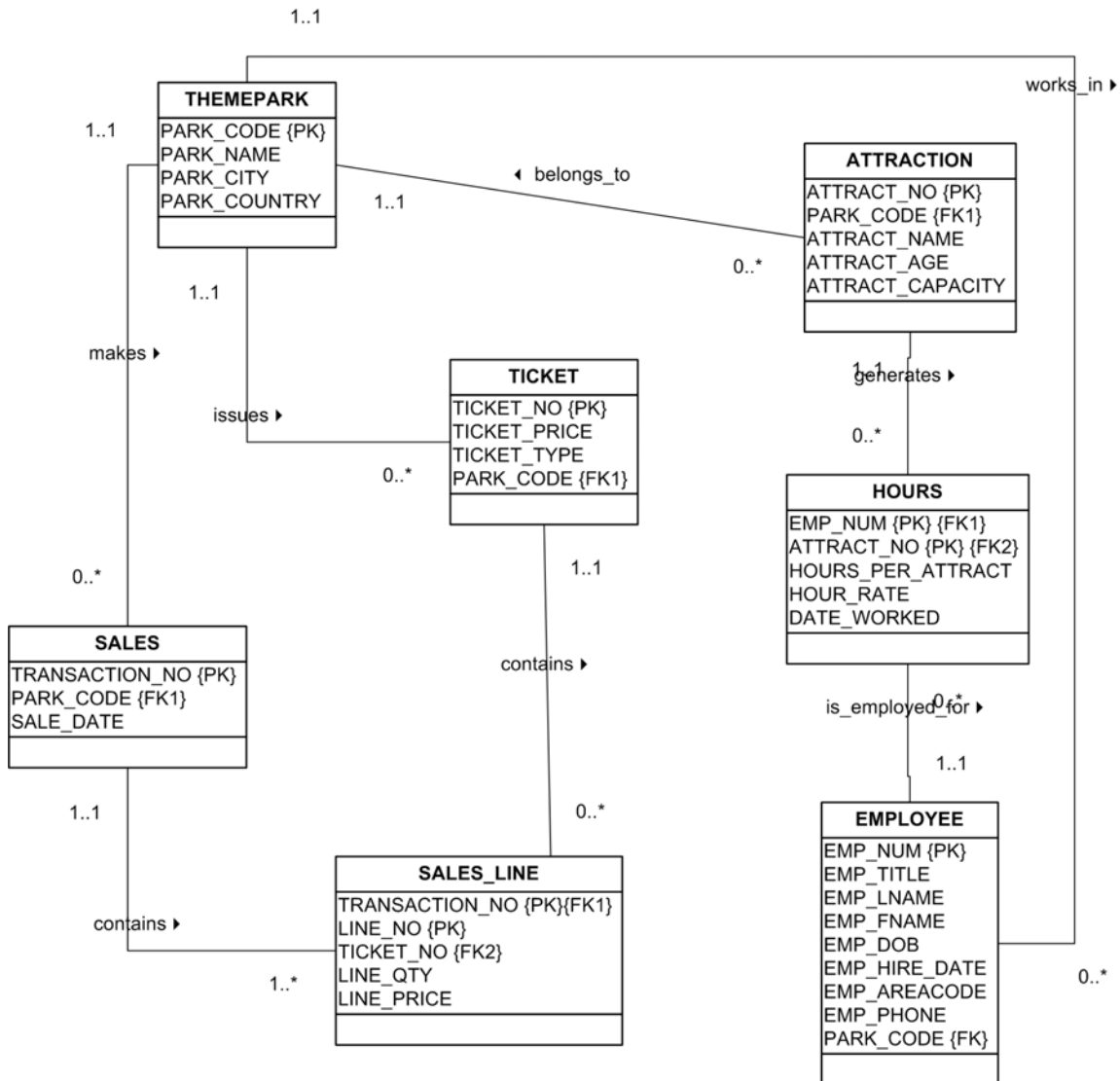
- Create table structures using MySQL data types
- Apply SQL constraints to MySQL tables
- Create a simple index

### **2.1 Introduction**

In this section you will learn how to create a small database called Theme Park from the ERD shown in Figure 11. This will involve you creating the table structures in MySQL using the `CREATE TABLE` command. In order to do this, appropriate data types will need to be selected from the data dictionary for each table structure along with any constraints that have been imposed (e.g. primary and foreign key). Converting any ER model to a set of tables in a database requires following specific rules that govern the conversion. The application of those rules requires an understanding of the effects of updates and deletions on the tables in the database. You can read more about these rules in Chapter 8, Introduction to Structured Query Language, and Appendix D, Converting an ER Model into a Database Structure.

### **2.2 The Theme Park Database**

Figure 11 shows the ERD for the Theme Park database which will be used throughout this lab guide.



**Figure 11 The Theme park Database ERD**

Table 2.1 Shows the Data Dictionary for the Theme Park database which will be used to create each table structure.

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**Table 2.1 Data Dictionary for the Theme Park Database**

Table Name	Attribute Name	Contents	Data Type	Format	Range	Required	PK or FK	FK Referenced Table
THEMEPARK	PARK_CODE	Park code	VARCHAR(10)	XXXXXXXX	NA	Y	PK	
	PARK_NAME	Park Name	VARCHAR(35)	XXXXXXXX	NA	Y		
	PARK_CITY	City	VARCHAR(50)		NA	Y		
	PARK_COUNTRY	Country	CHAR(2)	XX	NA	Y		
EMPLOYEE	EMP_NUM	Employee number	NUMERIC(4)	##	0000 – 9999	Y	PK	
	EMP_TITLE	Employee title	VARCHAR(4)	XXXX	NA	N		
	EMP_LNAME	Last name	VARCHAR(15)	XXXXXXXX	NA	Y		
	EMP_FNAME	First Name	VARCHAR(15)	XXXXXXXX	NA	Y		
	EMP_DOB	Date of Birth	DATE	DD-MON-YY	NA	Y		
	EMP_HIRE_DATE	Hire date	DATE	DD-MON-YY	NA	Y		
	EMP_AREACODE	Area code	VARCHAR(4)	XXXX	NA	Y		
	EMP_PHONE	Phone	VARCHAR (12)	XXXXXXXX	NA	Y		
	PARK_CODE	Park code	VARCHAR(10)	XXXXXXXX	NA	Y	FK	THEMEPARK

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TICKET	TICKET_NO	Ticket number	NUMERIC(10)	#####	NA	Y		
	TICKET_PRICE	Price	NUMERIC(4,2)	####.##	0.00 – 0000.00			
	TICKET_TYPE	Type of ticket	VARCHAR(10)	XXXXXXXXXX	Adult, Child, Senior, Other			
	PARK_CODE	Park code	VARCHAR(10)	XXXXXXXXXX	NA	Y	FK	THEMEPARK
ATTRACTION	ATTRACT_NO	Attraction number	NUMERIC(10)	#####	N/A	Y	PK	
	PARK_CODE	Park code	VARCHAR(10)	XXXXXXXXXX	NA	Y	FK	THEMEPARK
	ATTRACT_NAME	Name	VARCHAR(35)	XXXXXXX	N/A	N		
	ATTRACT_AGE	Age	NUMERIC(3)	###	Default 0	Y		
	ATTRACT_CAPACITY	Capacity	NUMERIC(3)	###	N/A	Y		
HOURS	EMP_NUM	Employee number	NUMERIC(4)	##	0000 – 9999	Y	PK / FK	EMPLOYEE
	ATTRACT_NO	Attraction number	NUMERIC(10)	#####	N/A	Y	PK / FK	ATTRACTION
	HOURS_PER_ATTRACT	Number of hours	NUMERIC(2)	##	N/A	Y		
	HOURLY_RATE	Hourly Rate	NUMERIC(4,2)	####.##	N/A	Y		
	DATE_WORKED	Date worked	DATE	DD-MON-YY	N/A	Y		

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SALES	TRANSACTION_ NO	Transaction No	NUMERIC	#####	N/A	Y	PK	
	PARK_CODE	Park code	VARCHAR(10)	XXXXXXX	NA	Y	FK	THEMEPA RK
	SALE_DATE	Date of Sale	DATE	DD-MON-YY	SYSDATE	Y		
SALESLINE	TRANSACTION_ NO	Transaction No	NUMERIC	#####	N/A	Y	PK / FK	SALES
	LINE_NO	Line number	NUMERIC(2)	##	N/A	Y		
	TICKET_NO	Ticket number	NUMERIC(10)	#####	NA	Y	FK	TICKET
	LINE_QTY	Quantity	NUMERIC(4)	####	N/A	Y		
	LINE_PRICE	Price of line	NUMERIC(9,2)	#####.##	N/A	Y		

### 2.3 Data Types in MySQL

In order to build tables in MySQL you will need to specify the data type for each column.

Table 2.2 shows some of the most common data types. If you have previously used an ORACLE DBMS, you will notice that the syntax is different.

**Table 2.2 Common MySQL data types<sup>1</sup>**

Data Type	Example	Description
CHAR(size)	<b>fieldName</b> <b>CHAR(10)</b>	Stores up to 255 characters. If the content is smaller than the field size, the content will have trailing spaces appended.
VARCHAR(size)	<b>fieldName</b> <b>VARCHAR(100)</b>	Stores up to 255 characters, and a minimum of 4 characters. No trailing spaces are appended to the end of this datatype.

<sup>1</sup> This table was adapted from the web site <http://www.developerfusion.co.uk/>. A comprehensive and complete list of types can be taken from the MySQL Reference Manual.

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MySQL keeps track of a delimiter to keep track of the end of the field.

TINYTEXT	fieldName TINYTEXT	Stores up to 255 characters. Equivalent to VARCHAR(255).
TEXT	fieldName TEXT	Stores up to 65,535 characters. An Index can be created on the first 255 characters of a field with this data type.
MEDIUMTEXT	fieldName MEDIUMTEXT	Stores up to 16,777,215 characters. An Index can be created on the first 255 characters of a field with this data type.
LONGTEXT	fieldName LONGTEXT	Stores up to 4,294,967,295 characters. An Index can be created on the first 255 characters of a field with this data type.
ENUM	fieldName ENUM('Yes', 'No')	Note: The maximum size of a string in MySQL is currently 16 million bytes, so this data types is not useful at the moment.  Stores up to 65,535 enumerated types. The DEFAULT modifier may be used to specify the default value for this field.
		Stores a signed or unsigned integer number. Unsigned integers have a range of 0 to 4,294,967,295, and signed integers have a range of -2,147,438,648 to 2,147,438,647. By default, the INT data type is signed. To create an unsigned integer, use the UNSIGNED attribute.
		fieldName INT UNSIGNED
INT	fieldName INT	The ZEROFILL attribute may be used to left-pad any of the integer with zero's.
		fieldName INT ZEROFILL
		The AUTO_INCREMENT attribute may be used with any of the Integer data types. The following example could be used to create a primary key using the AUTO_INCREMENT attribute.
		fieldName INT UNSIGNED AUTO_INCREMENT PRIMARY KEY
TINYINT	fieldName TINYINT	Stores a signed or unsigned byte. Unsigned bytes have a range of 0 to 255, and signed bytes have a range of -128 to 127. By default, the TINYINT data type is signed.
MEDIUMINT	fieldName MEDIUMINT	Stores a signed or unsigned medium sized integer. Unsigned fields of this type have a range of 0 to 1,677,215, and signed fields of this type have a range of -8,388,608 to 8,388,607. By default, the MEDIUMINT data type is signed.
BIGINT	fieldName BIGINT	Stores a signed or unsigned big integer. Unsigned fields of this type have a range of 0 to 18,446,744,073,709,551,615, and signed fields of this type have a range of -9,223,372,036,854,775,808 to 9,223,372,036,854,775,807. By default, the BIGINT data type is signed.

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FLOAT	fieldName <b>FLOAT</b>	Used for single precision floating point numbers.
DOUBLE	fieldName <b>DOUBLE</b>	Used for double precision floating point numbers.
DATE	fieldName <b>DATE</b>	Stores dates in the format YYYY-MM-DD.
TIMESTAMP(size)	fieldName <b>DATETIME</b>	Stores dates and times in the format YYYY-MM-DD HH:MM:SS.  Automatically keeps track of the time the record was last ammended. The following table shows the formats depending on the size of TIMESTAMP

Size	Format
2	YY
4	YYMM
6	YYMMDD
8	YYYYMMDD
10	YYYYMMDDHH
12	YYYYMMDDHHMM
14	YYYYMMDDHHMMSS

DATETIME	fieldName <b>TIMESTAMP(14)</b>	
TIME	fieldName <b>TIME</b>	Stores times in the format HH:MM:SS.
YEAR(size)	fieldName <b>YEAR(4)</b>	Stores the year as either a 2 digit number, or a 4 digit number, depending on the size provided.

### 2.4 Creating the Table Structures

Use the following SQL commands to create the table structures for the Theme Park database. Enter each one separately to ensure that you have no errors. Successful table creation will prompt MySQL to say “Query OK”. It is useful to store each correct table structure in a script file, in case the entire database needs to be recreated again at a later date. You can use a simple text editor such as notepad in order to do this. Save the file as themepark.sql. Note that the table-creating SQL commands used in this example are based on the data dictionary shown in Table 2.1 and the MySQL data types in Table 2.2.

As you examine each of the SQL table-creating command sequences in the following tasks, note the following features:

- The NOT NULL specifications for the attributes ensure that a data entry will be made. When it is crucial to have the data available, the NOT NULL specification will not allow the end user to leave the attribute empty (with no data entry at all)..
- The UNIQUE specification creates a unique index in the respective attribute. Use it to avoid duplicated values in a column.
- The primary key attributes contain both a NOT NULL and a UNIQUE specification. Those specifications enforce the entity integrity requirements. If the NOT NULL and UNIQUE specifications are not supported, use PRIMARY KEY without the specifications.
- The entire table definition is enclosed in parentheses. A comma is used to separate each table element (attributes, primary key, and foreign key) definition.
- The DEFAULT constraint is used to assign a value to an attribute when a new row is added to a table. The end user may, of course, enter a value other than the default value. In MYSQL the default value must be a constant; it cannot be a function or an expression. This means, for example, that you cannot set the default for a date column to be the value of a function such as the system date like you can do in an ORACLE DBMS.



### *Note*

You will have learnt in Chapter 8 that referential integrity is usually implemented through the use of foreign keys. For a long time, the open-source MySQL RDBMS did not support the use of foreign keys. However, given the importance of maintaining referential integrity within the database this feature was introduced in later versions through the InnoDB table engine. The InnoDB engine provides MySQL with an ACID (Atomicity, Consistency, Isolation, Durability) compliant storage engine that has facilities such as commit and rollback. Full information about the InnoDB engine can be found in the MySQL Reference manual 5.0.

- The FOREIGN KEY CONSTRAINT is used to enforce referential integrity. In order to set up a foreign key relationship between two MySQL tables, three conditions must be met:
  1. Both tables must be of the InnoDB table type - see the note box.
  2. The fields used in the foreign key relationship must be indexed.
  3. The fields used in the foreign key relationship must be similar in data type.

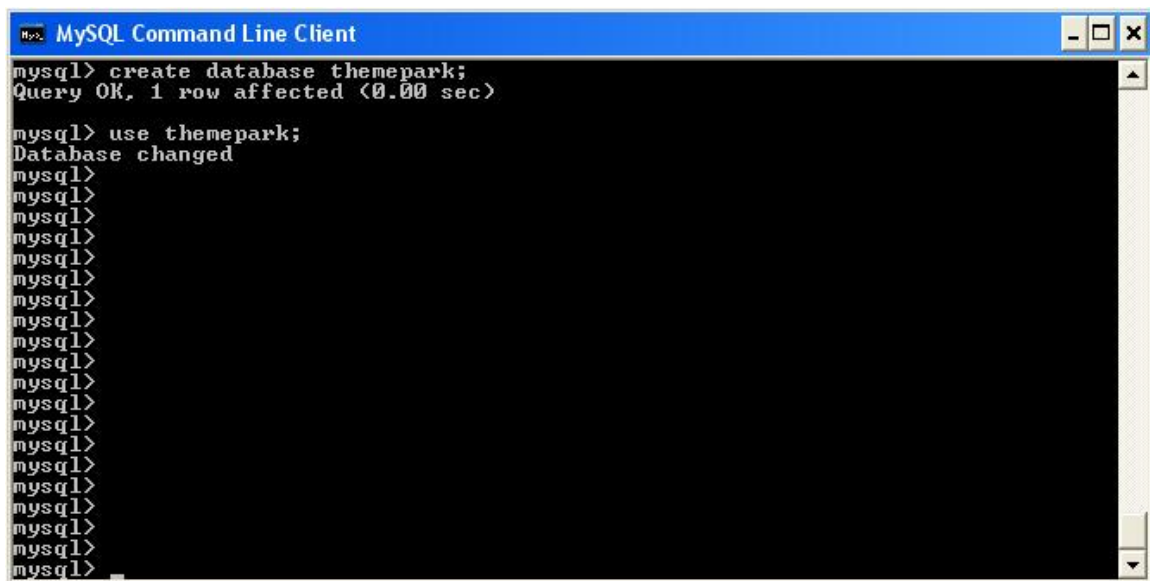
*Note*

MySQL 5.0 does not support the use of CHECK constraints which is used to validate data when an attribute value is entered.

### 2.4.1 Creating the THEMEPARK Database.

**Task 2.1** At the MySQL prompt; create a database called Theme Park as shown in Lab 1.

Then select the database for use as shown in Figure 12.



```
mysql> create database themepark;
Query OK, 1 row affected (0.00 sec)

mysql> use themepark;
Database changed
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
```

**Figure 12** Creating and using the Theme Park Database.

### 2.4.2 Creating the THEMEPARK TABLE

**Task 2.2** Enter the following SQL command to create the THEMEPARK table.

```
CREATE TABLE    THEMEPARK (
```

```
PARK_CODE      VARCHAR(10) PRIMARY KEY,  
PARK_NAME      VARCHAR(35) NOT NULL,  
PARK_CITY      VARCHAR(50) NOT NULL,  
PARK_COUNTRY   CHAR(2) NOT NULL);
```

Notice that when you create the THEMEPARK table structure you set the stage for the enforcement of entity integrity rules by using:

```
PARK_CODE      VARCHAR(10) PRIMARY KEY,
```

As you create this structure, also notice that the NOT NULL constraint is used to ensure that the columns PARK\_NAME, PARK\_CITY and PARK\_COUNTRY does not accept nulls.

Remember to store this CREATE TABLE structure in your themepark.sql script.

### 2.4.3 Creating the EMPLOYEE TABLE

**Task 2.3** Enter the following SQL command to create the EMPLOYEE table.

```
CREATE TABLE EMPLOYEE (  
EMP_NUM        NUMERIC(4) PRIMARY KEY,  
EMP_TITLE      VARCHAR(4),  
EMP_LNAME      VARCHAR(15) NOT NULL,  
EMP_FNAME      VARCHAR(15) NOT NULL,  
EMP_DOB        DATE NOT NULL,  
EMP_HIRE_DATE  DATE,
```

```
EMP_AREA_CODE VARCHAR(4) NOT NULL,  
  
EMP_PHONE      VARCHAR(12) NOT NULL,  
  
PARK_CODE      VARCHAR(10),  
  
INDEX          (PARK_CODE),  
  
CONSTRAINT     FK_EMP_PARK FOREIGN KEY(PARK_CODE) REFERENCES  
THEMEPARK(PARK_CODE));
```

As you look at the CREATE TABLE sequence, note that referential integrity has been enforced by specifying a constraint called FKP\_EMP\_PARK. In order to use foreign key constraints in MySQL, notice that the PARK\_CODE column is first indexed. This foreign key constraint definition ensures that you cannot delete a Theme Park from the THEMEPARK table if at least one employee row references that Theme Park and that you cannot have an invalid entry in the foreign key column.

Remember to store this CREATE TABLE structure in your themepark.sql script.

#### 2.4.4 Creating the TICKET TABLE

**Task 2.4** Enter the following SQL command to create the TICKET table.

```
CREATE TABLE TICKET (  
  
TICKET_NO      NUMERIC(10) PRIMARY KEY,
```

```
TICKET_PRICE    NUMERIC(4,2) DEFAULT 00.00 NOT NULL,  
TICKET_TYPE     VARCHAR(10),  
PARK_CODE       VARCHAR(10),  
INDEX           (PARK_CODE),  
CONSTRAINT      FK_TICKET_PARK FOREIGN KEY(PARK_CODE)  
REFERENCES THEMEPARK(PARK_CODE));
```

As you create the TICKET table, notice that both PRIMARY and FOREIGN KEY constraints have been applied. Remember to store this CREATE TABLE structure in your themepark.sql script.

#### 2.4.5 Creating the ATTRACTION TABLE

**Task 2.5** Enter the following SQL command to create the ATTRACTION table.

```
CREATE    TABLE ATTRACTION (  
ATTRACT_NO      NUMERIC(10) PRIMARY KEY,  
ATTRACT_NAME    VARCHAR(35),  
ATTRACT_AGE     NUMERIC(3) DEFAULT 0 NOT NULL,  
ATTRACT_CAPACITY NUMERIC(3) NOT NULL,  
PARK_CODE       VARCHAR(10),  
INDEX           (PARK_CODE),
```

```
CONSTRAINT      FK_ATTRACT_PARK FOREIGN KEY(PARK_CODE)
REFERENCES THEMEPARK(PARK_CODE));
```

Remember to store this CREATE TABLE structure in your themepark.sql script.

#### 2.4.6 Creating the HOURS TABLE

**Task 2.6** Enter the following SQL command to create the HOURS table.

```
CREATE TABLE HOURS (
EMP_NUM          NUMERIC(4),
ATTRACT_NO       NUMERIC(10),
HOURS_PER_ATTRACT NUMERIC(2) NOT NULL,
HOUR_RATE        NUMERIC(4,2) NOT NULL,
DATE_WORKED      DATE NOT NULL,
INDEX            (EMP_NUM),
INDEX            (ATTRACT_NO),
CONSTRAINT       PK_HOURS PRIMARY KEY(EMP_NUM, ATTRACT_NO,
DATE_WORKED),
CONSTRAINT       FK_HOURS_EMP FOREIGN KEY (EMP_NUM)
REFERENCES EMPLOYEE(EMP_NUM),
```

```
CONSTRAINT      FK_HOURS_ATTRACT FOREIGN KEY (ATTRACT_NO)
REFERENCES ATTRACTION(ATTRACT_NO));
```

As you create the HOURS table, notice that the HOURS table contains FOREIGN KEYS to both the ATTRACTION and the EMPLOYEE table.

Remember to store this CREATE TABLE structure in your themepark.sql script.

### 2.4.7 Creating the SALES TABLE

**Task 2.7** Enter the following SQL command to create the SALES table.

```
CREATE TABLE SALES (
TRANSACTION_NO      NUMERIC PRIMARY KEY,
PARK_CODE           VARCHAR(10),
SALE_DATE           DATE NOT NULL,
INDEX              (PARK_CODE),
CONSTRAINT      FK_SALES_PARK FOREIGN KEY(PARK_CODE)
REFERENCES THEMEPARK(PARK_CODE));
```

Remember to store this CREATE TABLE structure in your themepark.sql script.

### 2.4.8 Creating the SALESLINE TABLE

**Task 2.8** Enter the following SQL command to create the SALES\_LINE table.

```
CREATE TABLE SALES_LINE (  
  
    TRANSACTION_NO      NUMERIC,  
  
    LINE_NO              NUMERIC(2,0) NOT NULL,  
  
    TICKET_NO            NUMERIC(10) NOT NULL,  
  
    LINE_QTY              NUMERIC(4) DEFAULT 0 NOT NULL,  
  
    LINE_PRICE            NUMERIC(9,2) DEFAULT 0.00 NOT NULL,  
  
    INDEX                (TRANSACTION_NO),  
  
    INDEX                (TICKET_NO),  
  
    CONSTRAINT          PK_SALES_LINE PRIMARY KEY  
    (TRANSACTION_NO,LINE_NO),  
  
    CONSTRAINT          FK_SALES_LINE_SALES FOREIGN KEY  
    (TRANSACTION_NO) REFERENCES SALES(TRANSACTION_NO) ON DELETE  
    CASCADE,  
  
    CONSTRAINT          FK_SALES_LINE_TICKET FOREIGN KEY (TICKET_NO)  
    REFERENCES TICKET(TICKET_NO));
```

As you create the SALES\_LINE table, examine the constraint called

FK\_SALES\_LINE\_SALES. What is the purpose of ON DELETE CASCADE?

Remember to store this CREATE TABLE structure in your themepark.sql script.

## 2.5. Creating Indexes



You learned in Chapter 3, “The Relational Database Model,” that indexes can be used to improve the efficiency of searches and to avoid duplicate column values. Using the **CREATE INDEX** command, SQL indexes can be created on the basis of any selected attribute. For example, based on the attribute EMP\_LNAME stored in the EMPLOYEE table, the following command creates an index named EMP\_LNAME\_INDEX:

```
CREATE INDEX EMP_LNAME_INDEX ON EMPLOYEE(EMP_LNAME(8));
```

In MySQL, indexes can only be created using only the leading part of column values. So in the example an index is created using the first 8 characters of the EMP\_LNAME column.

**Task 2.9** Create the EMP\_LNAME\_INDEX shown above. Add the CREATE INDEX SQL command to your script file themepark.sql.

The **DROP TABLE** command permanently deletes a table (and thus its data) from the database schema. When you write a script file to create a database schema, it is useful to add DROP TABLE commands at the start of the file. If you need to amend the table structures in any way, just one script can then be run to re-create all the database structures. Primary and foreign key constraints control the order in which you drop the tables – generally you drop in the reverse order of creation. The DROP commands for the Theme Park database are:

```
DROP TABLE SALES_LINE;
```

```
DROP TABLE SALES;
```

DROP TABLE HOURS;

DROP TABLE ATTRACTION;

DROP TABLE TICKET;

DROP TABLE EMPLOYEE;

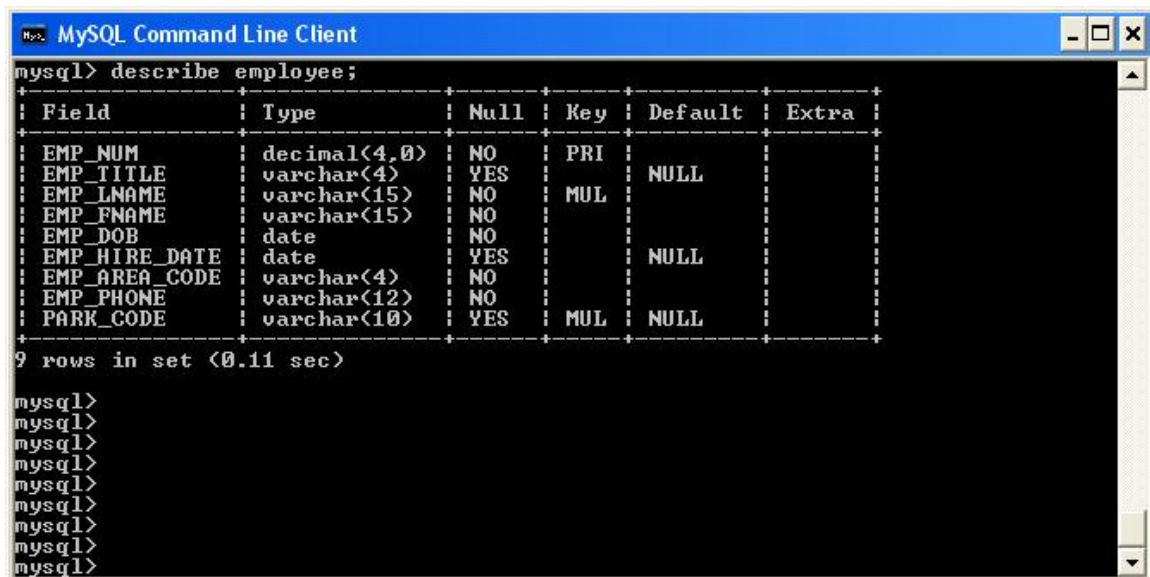
DROP TABLE THEMEPARK;

**Task 2.10.** Add the DROP commands to the start of your script file and then run the themepark.sql script.

## 2.6 Display a table's structure

The command **DESCRIBE** is used to display the structure of an individual table. To see the structure of the EMPLOYEE table you would enter the command:

DESCRIBE EMPLOYEE as shown in Figure 13.



```
mysql> describe employee;
```

Field	Type	Null	Key	Default	Extra
EMP_NUM	decimal(4,0)	NO	PRI		
EMP_TITLE	varchar(4)	YES		NULL	
EMP_LNAME	varchar(15)	NO	MUL		
EMP_FNAME	varchar(15)	NO			
EMP_DOB	date	NO			
EMP_HIRE_DATE	date	YES		NULL	
EMP_AREA_CODE	varchar(4)	NO			
EMP_PHONE	varchar(12)	NO			
PARK_CODE	varchar(10)	YES	MUL	NULL	

```
9 rows in set (0.11 sec)

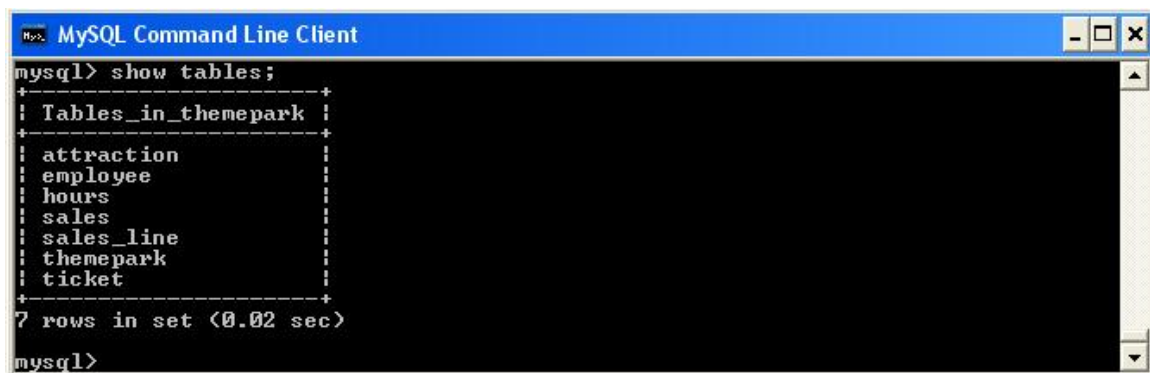
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
mysql>
```

Figure 13 Describing the structure of the THEMEPARK Table

**Task 2.10** Use the DESCRIBE command to view the structure of the other database tables that you have created in this lab.

## 2.7 Listing all tables

**Task 2.11** Use the SHOW TABLES command as shown in Figure 14, to list all tables that have been created within the THEMEPARK database.



```
mysql> show tables;
+-----+
| Tables_in_themepark |
+-----+
| attraction           |
| employee             |
| hours               |
| sales                |
| sales_line           |
| themepark            |
| ticket               |
+-----+
7 rows in set (0.02 sec)

mysql>
```

Figure 14 Displaying all tables

## 2.8 Altering the table structure

All changes in the table structure are made by using the **ALTER TABLE** command, followed by a keyword that produces the specific change you want to make. Three options are available: ADD, MODIFY, and DROP. ADD enables you to add a column, and MODIFY enables you to change column characteristics. Most RDBMSs do not allow you to delete a column (unless the column does not contain any values) because such an action may delete crucial data that are used by other tables.

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Supposing you wanted to modify the column ATTRACT\_CAPACITY in the ATTRACTION table by changing the data characteristics from NUMERIC(3) to NUMERIC(4). You would execute the following command:

```
ALTER TABLE ATTRACTION  
  
MODIFY ATTRACT_CAPACITY NUMERIC(4);
```

### **Note**

Some DBMSs impose limitations on when it's possible to change attribute characteristics. The reason for this restriction is that an attribute modification will affect the integrity of the data in the database. In fact, some attribute changes can be done only when there are no data in any rows for the affected attribute.

You can learn more about altering a table's structure in Chapter 8, "Introduction to Structured Query Language".

You have now reached the end of the first MySQL lab. The tables that you have created will be used in the rest of this lab guide to explore the use of SQL in MySQL in more detail.