

In this chapter you will learn;

- definition of database
- advantages of using a database
- special characteristics of a database
- using fields to create tables
- identifying key fields
- relational databases
- relationships between tables
- using queries to get data
- using data forms
- using reports to furnish information

9.1 Database Concept

In our daily lives, we have to deal with data. Although we can store and process small amounts of data in our memory, we cannot handle large amounts in the same way. In such situations, databases are used to store and organize data systematically.

On such occasions writing these data is one method. That is called manual database. The other method is to maintain the data on an electronic medium. This is called an electronic database.

Examples

It would be easy for you to remember names of your friends, but it would be difficult to retain all their phone numbers in your memory. You can get these details easily when needed if you write names and phone numbers in a book (Figure 9.1) or save them in a mobile phone (Figure 9.2). Thus, the phone book can be considered a simple manual database.

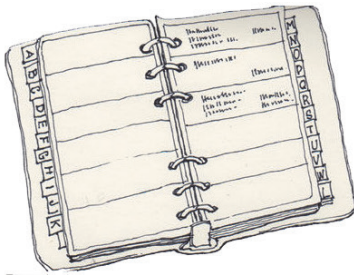


Figure 9.1 – telephone numbers
(manual database)

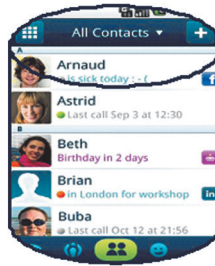


Figure 9.2 – telephone numbers
(electronic database)

Database and Data set

A database is a collection of logically organized data.

Ex: Telephone directory

A data set is a collection of data that is not logically organized.

Ex: Data contained in a word processing document, data in a spreadsheet

Defining a Database

A collection of data, organized in a certain manner, is defined as a database.

9.1.1 Manual and Electronic Databases

In an electronic database, data can be saved in a very small space which consists of an audio or video medium. Given below is a comparison of electronic and manual databases (Table 9.1).

Table 9.1 – comparison of manual and electronic database

Manual Database	Electronic Database
Less efficient	More efficient
Less accurate	More accurate
Less credible	More credible
Difficult to analyze data	Easy to analyze data
Should present in the order of input	Can be changed the data input order
Difficult to delete unnecessary data	Easy to delete unnecessary data
Difficult to update data	Easy to update data
More space is needed to save data	A very small space is needed to save data
More man power is needed	Less man power is needed
Difficult to share data	Easy to share data
Data cannot be validated	Data can be validated
Access control is difficult	Access control is easy

9.1.2 Features of a Database

1. **Minimal data redundancy:** If the same data is stored in several tables, this is called data redundancy. Data redundancy should be minimized in a good database.
2. **Maintain data consistency:** The existence of different values for the same data in multiple tables is called inconsistency. This should be eliminated. Thus, data consistency can be maintained.

For instance, the name of a student may be recorded separately in the admission card and the library membership card. When a name is changed, that name should be edited separately in all documents. Given below is an example where the name ‘Firosa Lai’ is changed as ‘Firosa Rafeeq’.

Table 9.2 – Admission_table

Student Number	Name	Date of Birth	Date of Admission	Name of the Guardian
100	Manoj Dayarathne	2/9/2008	1/1/2014	G. Dayarathne
101	Firoza Rafeeq	4/2/2008	1/1/2014	K. Fais

Table 9.3 - Library_membership_table

Student Name	Name of the Book	Borrowed Date	Return Date
Firoza Lai	Folk Songs	2/9/2014	16/9/2014
Manoj Dayarathne	Drama	3/9/2014	17/9/2014
Firoza Lai	Basic Maths Concept	3/9/2014	17/9/2014
Manoj Dayarathne	Principles of media	4/9/2014	18/9/2014

In this case, repeatedly entering the record under the name Firoza Lai in several locations is known as **data redundancy**.

Furthermore, when the name is updated to Firoza Rafeeq only in the admission table, the old name still remains in the library membership table. This situation, where the same data exists with different values is called **data inconsistency**.

However, by storing data in relational database tables, data redundancy can be eliminated or minimized. In the following tables, a student name is recorded only in one table.

Table 9.4 – Relational Database

Student Number	Name	Date of Birth	Date of Admission	Name of the Guardian
100	Manoj Dayarathne	2/9/2008	1/1/2014	G. Dayarathne
101	Firosa Rafeeq	4/2/2008	1/1/2014	K. Fais

Student Number	Book Number	Borrowed Date	Return Date
101	2222	2/9/2014	16/9/2014
100	3333	3/9/2014	17/9/2014
101	1111	3/9/2014	17/9/2014
100	4444	4/9/2014	18/9/2014

Book Number	Title	Author's Name
1111	Basic Maths Concept	Sivathasan Ramanathana
2222	Folk Songs	Jayantha Bandara
3333	Drama	Padmamali Menike
4444	Principles of Media	Methuki Thisansa

3. Increases efficiency: Since database tables are properly organized, saving and reading data can be carried out efficiently. Hence, efficiency is higher.

4.Increases accuracy: Since data redundancy can be minimized in a database, data consistency is maintained. This increases accuracy.

Let us consider the example above where Firosa Lai is changed to Firosa Rafeeq. If several places are corrected, one mistake would lead to inaccurate information.

However, in the above database only one table is need to be updated to change Firosa Lai to Firosa Rafeeq. This ensures data consistency. Therefore, the accuracy of data is very high.

5.Increases validity: Properties of fields can be assigned when a database is planned. Validity can be checked at the data entry stage. This increases the validity of the database.

For instance, field attributes can be imposed as fees to be indicated in two decimals with minimum fees being 1000 which is mandatory.

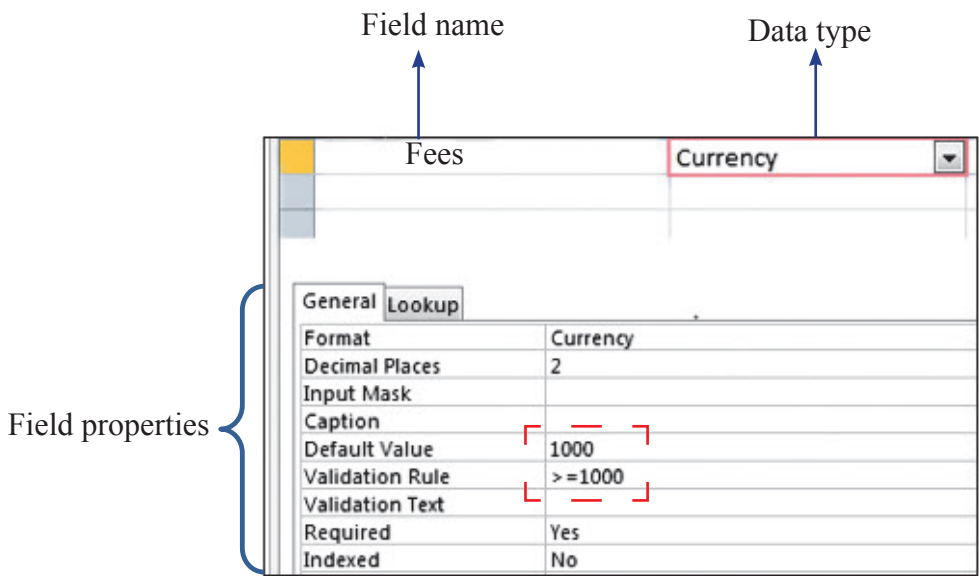
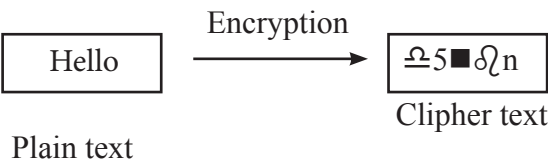


Figure 9.3 – Properties of data type

6. Security: Unauthorized access can be controlled by using a password and encrypting the database. This increases security.

Data encrypting is translating data in such a way that unauthorized personnel cannot read it. In the following figure 9.4, data available in Employee table are encrypted so as it cannot be understood by an unauthorized person



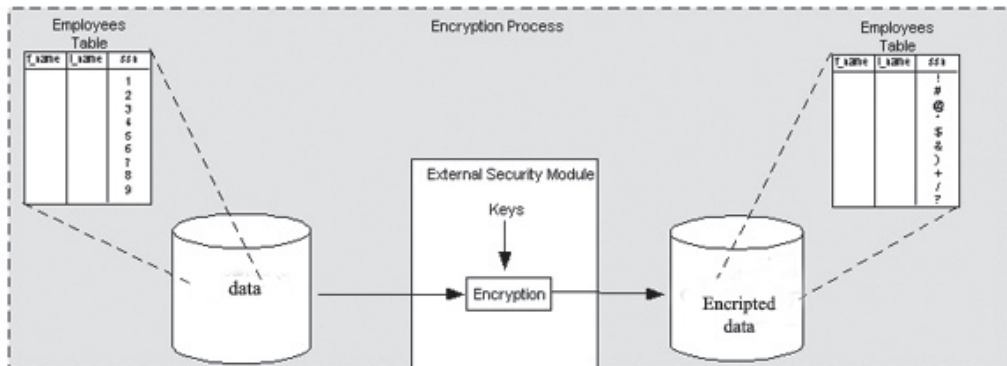


Figure 9.4 – Data Encryption

9.1.3 Database Models

Databases can be categorized into several types based on the models used to organize the data. The following are some of the models used in the construction of a database.

- Network Model
- Hierarchical Model
- Object relational Model
- Relational Model

9.1.4 Introduction to Relational Database

A collection of fields related to one entity is called a record. A collection of records is called a data table.

A collection of related tables is called a relational database.

9.1.5 Structure of a database

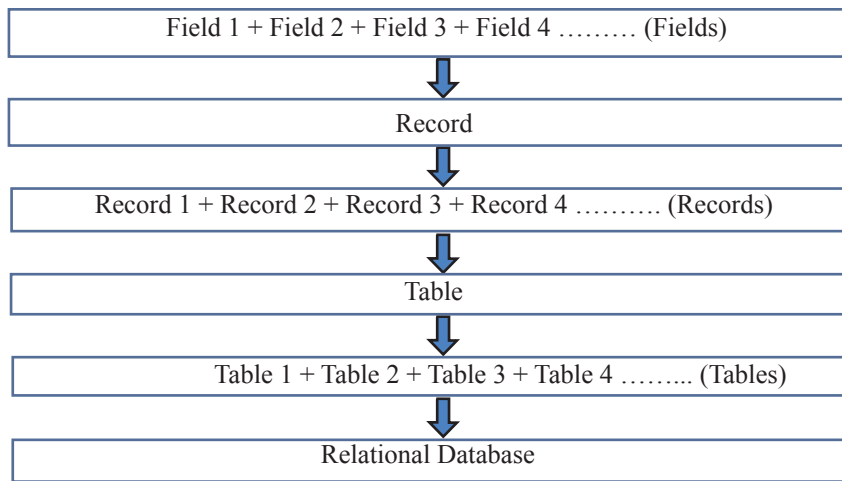


Figure 9.5 – The structure of a relational database

Bio data of three students are given below. (Table 9.5)

Table 9.5 – Biodata form

Admission No: 1426	Admission No: 1427	Admission No: 1428
Name: Kavindu Prabashwara	Name: Meenadevi Ramanathan	Name : Mohommad Malikkar
Date of Birth: 2005.05.23	Date of Birth: 2005.08.12	Date of Birth: 2005.02.07
Gender: Male	Gender: Female	Gender: Male
Tel No: 0352287571	Tel No: 0352235696	Tel No: 0352815402

Five details related to each student are given above. Thus, data such as Kavindu Prabashwara, Meenadevi Ramanathan, Mohommad Malikkar represent one field. To name such a field, a ‘field name’ is used. Data type is used to define the kind of data that can be stored in a particular field.

Let us create a table recording details under each field name. (Table 9.6)

Table 9.6 – Student Records

Admission No	Name	Date of Birth	Gender	Phone Number
1426	Kavindu Prabashwara	2005.05.23	Male	0352287571
1427	Meenadevi Ramanathan	2005.08.12	Female	0352235696
1428	Mohommad Malikkar	2005.02.07	Male	0352815402

A column of the table represents one field. Thus, the above table consists of five fields. They are Admission No, Name, Date of Birth, Gender and Phone Number.

A collection of fields related to a certain object makes a record. Hence, the above table has three records.

There is the possibility of entering the same data again in the columns such as Name, Date of Birth, Gender and Phone Number. However, a datum entered in the column of Admission No will not be repeated. Hence, the field Admission No is more suitable to uniquely identify a record.

What are the books borrowed by Firosa Rafeeq? Let us learn how this is found in relevant tables:

Student Number	Name	Date of Birth	Date of Admission	Name of the Guardian
100	Manoj Dayarathne	2/9/2008	1/1/2014	G. Dayarathne
101	Firosa Rafeeq	4/2/2008	1/1/2014	K. Fais

Student Number	Book Number	Date Borrowed	Date Returned
101	2222	2/9/2014	16/9/2014
100	3333	3/9/2014	17/9/2014
101	1111	3/9/2014	17/9/2014
100	3333	4/9/2014	18/9/2014

Book Number	Title	Author's Name
1111	Basic Maths Concept	Sivathasan Ramanathan
2222	Folk Songs	Jayantha Bandara
3333	Drama	Padmamali Menike
4444	Principles of Media	Methuki Thisansa

Activity



Observe how the records listed in the above tables are related to each other.

9.1.6 Degree and Cardinality

The number of fields in a data table is referred to as its degree, and the number of records is referred to as its cardinality. In the following student data table, the degree is 5 and the cardinality is 3.

Table 9.7 – Student Details

Admission No	Name	Date of Birth	Gender	Phone Number
1426	Kavindu Prabashwara	2005.05.23	Male	0352287571
1427	Meenadevi Ramanathan	2005.08.12	Female	0352235696
1428	Mohammad Malikkar	2005.02.07	Male	0352815402

9.1.7 Primary Key

A column (or a combination of columns) which enables to identify a record uniquely is called primary key.



Example -
National Identity Card Number, School Admission Number

Observation



Special attributes of a primary key

- Should not be empty (Not null – data being there is mandatory)
- No duplicate values (same values do not exist)

For instance, study the table given below which consists of data on a few books.

Table 9.8 - Book Table

Accession No	Title	Author's Name	Price of a Book	Number of Books
2131	Let's Access Internet	Mahesh Gankanda	Rs.275.00	10
2132	Computer Studies	Suranimala Basnayaka	Rs.300.00	5
2133	Essay Writing	Nimali Bogoda	Rs.225.00	12
2134	Education Psychology	Dayanath Jayasekara	Rs.400.00	6
2135	Tamil Language Learning	Raj Sudakaran	Rs.225.00	8
2136	Computer Studies	Mohammad Niyas	Rs.150.00	4
2137	Sinhala Tamil Dictionary	Raj Sudakaran	Rs.325.00	6

In this table,

- Accession numbers do not have duplicates (unique).
- Both authors Suranimala Basnayaka and Mohammad Niyas have authored Computer Studies.
- Raj Sudakaran has authored both Tamil Language Learning and Sinhala Tamil Dictionary.
- The price of both books Essay Writing and Tamil Language Learning is the same.
- Both books Education Psychology and Sinhala Tamil Dictionary have six copies.

According to these details, the Accession Number is the most suitable fields for the primary key.

Note: The Primary key of a table is underlined to identify as unique. (table 9.9)

Table 9.9 – Indication of the primary key

<u>Accession No</u>	Title	Author's Name	Price of a Book	Number of Books

9.1.8 Composite Primary Key

The primary key which consists of two or more columns of a table uniquely identifies a record is called Composite Primary Key.

Example

Look at the table given below about the captain and vice-captain of a school.

Table	9.10	–	Sports	Table
Year	Sport		Captain	Vice Captain
2013	Cricket		Rash Senarathne	Mubharak Husein
2013	Football		Jaliya Saranga	Vinothen Raj
2013	Volleyball		Ahammed Nawas	Sudesh Tharanga
2014	Cricket		Mubharak Husein	Bhanu Dayarathna
2014	Football		Jaliya Saranga	Ahammed Nawas
2014	Volleyball		Bhathiya Gamlath	Sudesh Tharanga

Composite Key  **Both the year and sport are needed to uniquely identify a record.**

Since the column data of this table contains duplicate, there is no single column to uniquely identify records. There should be a definite captain and a vice captain for a sport in a year. Hence, as far as the combination of two columns; year and sport is considered, identity of records exists. Hence, combination of both fields 'year' and 'sport' can be considered as the primary key. The composite key made of the combination of these two columns is suitable for the primary key in this table. When indicating the composite primary key, fields are separately underlined. (Refer Table 9.11)

Table 9.11 – Indication of the composite primary key

<u>Year</u>	<u>Sport</u>	Captain	Vice Captain

The composite primary key of this table = Year + Sport

9.1.9 Foreign Key

If a field (or a combination of fields) of one table can be used to uniquely identify a row of another table, this/these field/s is/are called the foreign key. This key builds a connection of two tables.

Table 9.12 – Student Table

<u>Registration Number</u>	Name	Date of Birth	Date of Admission	Name of the Guardian
100	Manoj Dayarathne	2/9/2014	1/1/2014	G. Dayarathne
101	Firoza Rafeeq	4/2/2014	1/1/2014	K.Fais

Primary key of
Student Table

Primary key of
Student Table

Table 9.13 – Subject Table

<u>Candidate No</u>	Maths	Science	Sinhala	English	Registration No
449683	B	A	C	C	100
449697	A	B	B	A	101

Foreign key of
Subject Table

Observation



Special features of a foreign key

- Builds a connection between two tables.
- The related table must contain records corresponding to the primary key field of the referenced table.
- Foreign key of one table is the primary key of the other table.

Example

Given below in Table 9.14 are ICT subject marks of three students scored in the first term.

Table 9.14 – First term marks

Admission No	Name	Date of Birth	Marks	Term	Year
1426	Kavindu Prabashwara	2005.05.23	69	1	2014
1427	Meenadevi Ramanathan	2005.08.12	82	1	2014
1428	Mohammad Malikkar	2005.02.07	47	1	2014

When entering marks of these students scored in the second term, the fields such as admission number, name and date of birth should be entered again. (Refer Table 9.15)

Table 9.15 – Second term marks

Admission No	Name	Date of Birth	Marks	Term	Year
1426	Kavindu Prabashwara	2005.05.23	69	1	2014
1427	Meenadevi Ramanathan	2005.08.12	82	1	2014
1428	Mohommad Malikkar	2005.02.07	47	1	2014
1426	Kavindu Prabashwara	2005.05.23	79	2	2014
1427	Meenadevi Ramanathan	2005.08.12	68	2	2014
1428	Mohommad Malikkar	2005.02.07	66	2	2014

Recording column data repeatedly is called data duplication.

Disadvantages of data duplication

- (i) Inability to select a primary key field to maintain identity of records.
- (ii) Inability to analyze data properly.

Though the number of students who have scored above 60 marks is 5 as per the above table, the actual number of students in the class is 3. Hence, a proper data analysis cannot be done.

- (iii) Reduced efficiency

When entering marks of several years in the above table, more time is spent to enter the admission number, name and date of birth of the same student. This reduces efficiency.

- (iv) Possibility to get inaccurate data is high.

There can be errors in entering the same data repeatedly. Mohommad Malikkar can be recorded as Mohommad Malakkar in another place. These mismatches can lead to inaccurate data. Hence, accuracy becomes low.

- (v) Difficult to input data.

To enter the marks of a student, his/her name and date of birth should be entered repeatedly.

- (vi) Possibility to make errors in deleting data.

As there are several records related to a student, there can be errors in deleting data.

- (vii) Difficult to update data.

As there are several records related to one student, attention should be paid to each record in updating it.

These difficulties are created as all data are stored in one table. Hence, to minimize such difficulties, a table can be divided into several tables.

Let us create two tables: Student Table and Marks Table, by removing the fields which cause data duplication.

Let us create Student Table (Table 9.16) which consists of Admission Number, Name and Date of Birth.

In the Student Table, there is the possibility of data in Name and Date of Birth fields being duplicated. However, data does not duplicate under Admission Number. Hence, Admission Number is more suitable to identify records uniquely. Therefore, the primary key of the Student Table is the Admission Number.

Table 9.16 – Student Table

Admission No	Name	Date of Birth
1426	Kavindu Prabashwara	2005.05.23
1427	Meenadevi Ramanathan	2005.08.12
1428	Mohommad Malikkar	2005.02.07

Let us create a Marks Table (Table 9.17) which consists of the Year, Term, Marks and Admission Number.

Table 9.17– Marks Table

Year	Term	Marks	Admission No
2014	1	69	1426
2014	1	82	1427
2014	1	47	1428
2014	2	79	1426
2014	2	68	1427
2014	2	66	1428

There is only one datum in the Student Table related to Admission Number of Marks Table.

Hence, the field of the Admission Number is the primary key of the Student Table and foreign key of the Marks Table.

In the Marks table, a composite primary key is created by combining the three fields: Year + Term + Admission No.

9.2 Creating a Simple Database Manually

Data type: a type of data related to one field is called a data type. Let us learn about some commonly used data types.

- Numeric: used for calculations. Exists in several forms.
 - * Integer : plus or minus whole numeric figures.
E.g.: 12, -23
 - * Real : plus or minus numbers with decimal places.
E.g.: 8.125, -2.64, 4.00
- Text: composed of letters, numbers or special characters (Eg- %, *, -). Though numbers are used, it is not used for calculations.
E.g.: National identity card number –889534731V, Name, Address
Telephone number –0112785123, 0112 – 985123
- Currency: used to indicate monetary values.
E.g.: \$12.45, Rs.35.00
- Date / Time: indicates dates and time
E.g.: 12/23/2013, 7.35 a.m
- Boolean: there are only two Boolean (logical) values; True/ False or Yes/ No.

The size of a field can be changed according to the data type entered into it and the number of characters it contains.

E.g.: Field Name (Column Name)	Number of fields (Column Width)
Subject Name	15
Subject Code	5

Data type related to the field should be identified when the table is created.

Field Name	Data Type
Accession number of the book	Text
Title	Text
Author's Name	Text
Price of Book	Currency
Number of Books	Number
Registration status	Yes/ No

Activity



- (1) Tabulate details of 10 books in your library under the fields mentioned above.
- (2) Create a table which is suitable to enter marks scored by the students in your class.
Include Admission Number, Name and the Marks for subjects you study in this table.

Mention the most suitable data type for the fields in Table given below.

Field	Data Type
Admission Number	
Date of Admission	
Subject Code	
Doctor's Fee	
Department Name	
Number of Passengers	
Is Registered?	

- (3) Explain with examples the importance of selecting the most suitable data type for fields.

9.3 Converting a Manual Database to an Electronic Medium

Let us learn electronic databases with the purpose of converting a manual database to an electronic medium.

Definition

A collection of objects which facilitates planning and maintenance of the database to the user is called a Database Management System (DBMS). This consists of several objects like tables, queries, forms and reports. (Refer Figure 9.6)

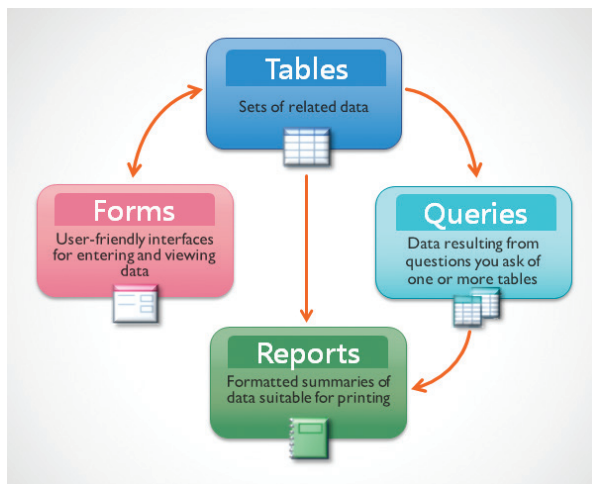
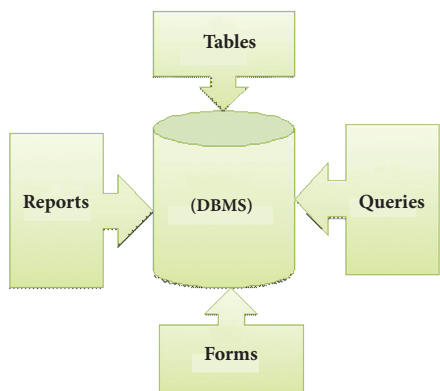


Figure 9.6 – Objects of a Database Management system

9.3.1 Database Management System Software

Given below in Table 9.18 are some DBMS software manufactured by various companies.

Table 9.18 – Various database management systems and manufacturing companies

Software	Manufacturing Company	Free and Open source/ Proprietary
Access	Microsoft Company	Proprietary
Base	The Document Foundation	Free and Open source
Oracle	Oracle Cooperation	Proprietary
My SQL	Oracle Cooperation	Free and Open source

9.3.2 Using of Database Management System Software

In this unit, only Microsoft Office Access and LibreOffice Base software are discussed.

1. Starting DBMS software

Please note that the commands used to run software can be different according to the operating system.

Microsoft Office Access

Start → Programs → Microsoft Office → Microsoft Office Access → Blank Database → Select Folder and Type Name → Create

LibreOffice Base

Start → Programs → LibreOffice → LibreOfficeBase → Create a new database → Next → Finish → Select Folder and Type Name → Save

2. Planning a Data Table

Open database software and plan a table with the fields and data types as given in 9.7. Name the table as 'Library'.

Microsoft OfficeAccess

Create → Table Design → Give the field name and data type → Design properties → Save the table



Design View

LibreOffice Base

Select Table in Design View → Give the field name and data type → Design properties → Save the table

Library	
Field Name	Data Type
Accession_Number	Text
Title	Text
Auther	Text
Price	Currency
Number_of_books	Number

Figure 9.7 – Fields and data types of Library Table.

3. Creating the Primary Key for a Data Table

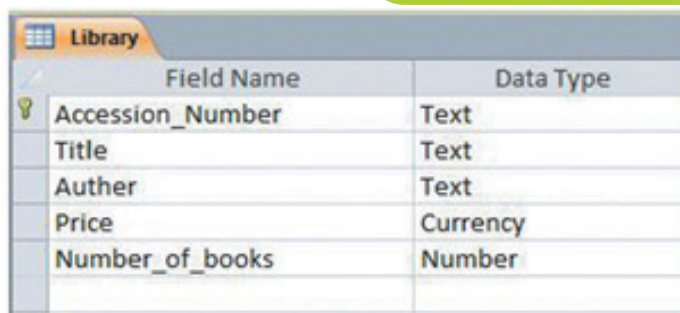
Identity of records can be maintained by using a column or a combination of columns of a table as a primary key field. The field 'Accession Number' in the above figure 9.7 is the most suitable field for the primary key field.

Microsoft OfficeAccess

Create → Table Design → Give the field name and data type → Select the row/rows that should be made as Primary key → Click on Primary key → Save the table.

LibreOffice Base

Select 'Table' in Design View → Give the field name and data type → Right click on the line which contains the field need making primary key → Select Primary key → Save the table.



Field Name	Data Type
Accession_Number	Text
Title	Text
Auther	Text
Price	Currency
Number_of_books	Number

Figure 9.8 – Fields and data types of Library Table.

4. Entering Data to the Table

The table view should be changed to input data to a prepared table.

Microsoft Office Access

Select the table from 'All Access Objects' window → Select 'Data Sheet View' → Enter data → Close the table



Datasheet View

LibreOffice Base

Double click the table under Tables or select Open by clicking the right button → Enter data → Close the table.

Enter data into the Library Table as shown in Figure 9.9

Accession_Number	Title	Author	Price	Number_of_books
2131	Access the Internet	Mahesh Gankanda	Rs. 275.00	10
2132	Computer Language Study	Suranimala Basnayaka	Rs. 300.00	5
2133	Essay Practice	Nimali Bogoda	Rs. 225.00	12
2134	Education Psychology	Dayanath Jayasekara	Rs. 400.00	6
2135	Learn Tamil Language	Raj Sudhakaran	Rs. 225.00	8
2136	Computer Language Study	Mohamed Niyas	Rs. 150.00	4
2137	Sinhala Tamil Dictionary	Raj Sudhakaran	Rs. 325.00	6

Figure 9.9 - Records of Library Table

9.4 Creating a Relational Database

Rather than keeping all the data in a single table, it is more efficient and productive to maintain data if those are recorded separately in different tables. Hence, let us study this section well to break a data table into several simple tables and to build relationships between these.

When creating a relational database, several types of relations can exist among tables. They are known as one-to-one, one-to-many and many-to-many.

9.4.2 One-to-one Relationship

If only a row of a table is related to a row of another table, it is called a one-to-one relationship.

Two tables exist as A and B. A row in table A is related to one row in Table B and a row in Table B is related to one row in Table A.

Example

Given below is Table 9.19 which includes the marks students scored of the Grade 5 scholarship exam.

Admission No	Name	Date of Birth	Index No	Marks
1426	Kavindu Prabashwara	2005.05.23	23234	151
1427	Meenadevi Ramanathan	2005.08.12	23876	186
1428	Mohammad Malikkar	2005.02.07	23758	172
1429	Rashmi Janodara	2005.06.16	23765	193

Given below is Table 9.19 which includes the marks students scored of the Grade

5 scholarship exam.

Table 9.21 -Students Table

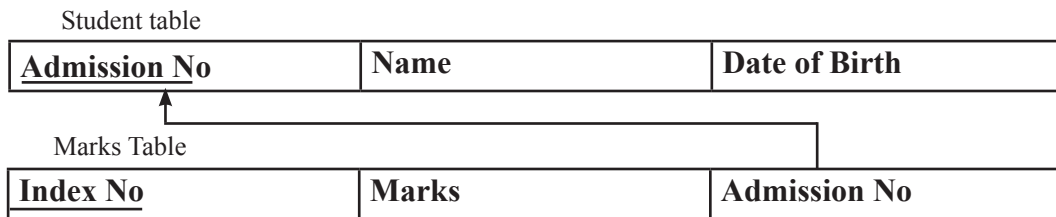
Table 9.20 - Marks

<u>Index No</u>	Marks	Admission No	<u>Admission No</u>	Name	Date of Birth
23234	151	1426	1426	Kavindu Prabashwara	2005.05.23
23876	181	1427	1427	Meenadevi Ramanathan	2005.08.12
23758	172	1428	1428	Mohommad Malikkar	2005.02.07
23765	193	1429	1429	Rashmi Janodara	2005.06.16

A record of the Marks Table is related to only one record of the Student Table. A record of the Student Table is related to only one record of the Marks Table as well.

The primary key of the Student Table is the Admission Number and it is the foreign key of the Marks Table. The Primary key of the Marks Table is the Index Number. The relationship built between these two tables through the foreign key is one-to-one. (Figure 9.10)

To create a one-to-one relationship, the primary key of one table is entered as a foreign key in the other table.



An arrow is drawn from the foreign key to the primary key to indicate the relationship.

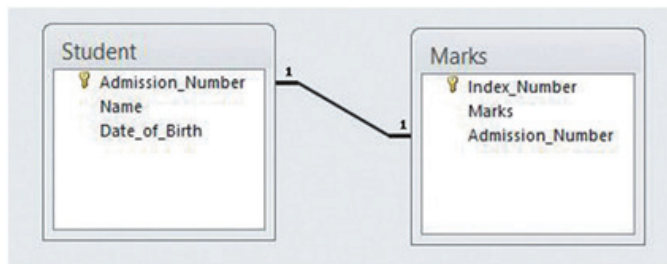


Figure 9.10 – Indicating one-to-one relationship

9.4.2 one-to-many Relationship

If one record of a table is related to several records of the other table, this is called a one-to-many relationship.

If the tables are A and B, and if B is the related table, the following Table 9.22 shows one-to-many relationship.

Table 9.22 Features of a one-to-many relationship

Table A	Table B (Related table)
A record in Table A can be related to several records in Table B.	Each record in Table B can be related to only one record in Table A.
There can be records which are not related to records of Table B.	There cannot be records of Table A.
Data in the column which includes the primary key cannot duplicate.	Data in the column which includes the foreign key can duplicate.
Having a record in Table related to a record in Table A is not mandatory.	It is mandatory to have at least one row in Table A which is related to Table B.

Example

Refer Table 9.23 given below which includes personal data of students and Table 9.23 Service and facility fees

Admission No	Name	Date of Birth	Receipt Number	Payment Date	Fees
1426	Kavindu Prabashwara	2005.05.23	1000	2014.01.04	40.00
1427	Meenadevi Ramanathan	2005.08.12			
1428	Mohommad Malikkar	2005.02.07	1001	2014.01.06	120.00
1426	Kavindu Prabashwara	2005.05.23	1002	2014.01.12	80.00

→ R

In this table, the fields 'Payment Date' and 'Fees' depend on the Field Receipt Number. Further, data is unique in the Receipt Number Field. The reason for this is that receipt numbers will not be same. Anyway, there can be incomplete records in the table as receipts should be issued in the order of payment. (Indicated as R in the table) Further, data duplication can also be seen here.

Hence, let us break this table into two tables: Table 9.24 –Student Table and 9.25 – Fees Table.

The Receipt Number is the primary key of the Fees Table.

Admission Number is the primary key of the Student Table and the Foreign Key of the Fees Table.

Table 9.24 - Students Table

<u>Admission No</u>	Name	Phone Number
1426	Kavindu Prabashwara	0352287571
1427	Meenadevi Ramanathan	0352235696
1428	Mohammad Malikkar	0352815402

Table 9.25 Facility Fees Table

<u>Receipt Number</u>	Payment Date	Fees	Admission No
→ 1000	2014.01.04	40.00	1426
→ 1001	2014.01.06	120.00	1428
→ 1002	2014.01.12	80.00	1426

If a student can pay fees a maximum of three times, there can be 0, 1, 2 or 3 rows in Facility Fees Table related to a record of the Student Table

- If number of records is 0, this means fee is not paid.
- If number of records is 1, this means fee is paid once only.
- If number of records is 2, this means fee is paid twice.
- If number of records is 3, this means fee is paid thrice.

Thus, there can be no or several rows in the Fees Table related to a row of the Student Table. Hence, the relationship between these two tables is one-to-many (Figure 9.11).

To create a one-to-many relationship, the primary key of the “one” table is entered as a foreign key in the related (“many”) table.

Student Table

<u>Admission No</u>	Name	Phone no
---------------------	------	----------

Facility Fee Table

<u>Facility Receipt No</u>	Payment Date	Fees	Admission No
----------------------------	--------------	------	--------------

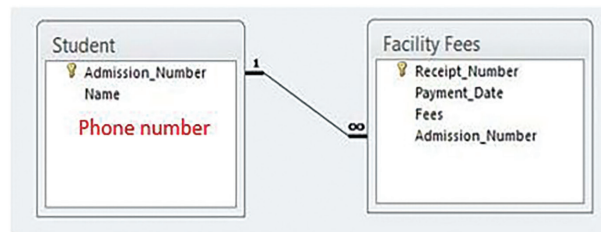


Figure 9.11 - One-to-Many Relationship

9.4.3 Many-to-many Relationship

If a record of a table is related to several records of another table and if a record of that table is related to several records of the first table, there is a many-to-many relationship between those two tables.

Example

Students take part in sports (team) as an extra-curricular activity. There are sports such as cricket, volleyball and football. A student can do at least one of these sports. Further, there should be a team for each sport.

Refer Table 9.26 given below which includes these data. According to this table,

Table 9.26 - Table of students who do sports

Admission No	Name	Date of Birth	Sport No	Sport	Team	Number of permanent members
1426	Kavindu Prabashwara	2005.05.23	S001	Cricket	A	11
1426	Kavindu Prabashwara	2005.05.23	S002	Football	A	16
1428	Mohammad Malikkar	2005.02.07	S001	Cricket	B	11
1428	Mohammad Malikkar	2005.02.07	S002	Football	A	16
1428	Mohammad Malikkar	2005.02.07	S003	Volleyball	B	06
1429	Janith Asheka	2005.04.15	S001	Cricket	A	11
1429	Janith Asheka	2005.04.15	S003	Volleybal	A	06

There is data duplication in this table. To minimize data duplication, let us break these data into separate tables. Include Sports data into Sports Table (9.27) and student data into Student Table (Table 9.28)

Table 9.27 - Student Table

<u>Admission No</u>	Facility fees Table	Date of Birth
1426	Kavindu Prabashwara	2005.05.23
1428	Mohammad Malikkar	2005.02.07
1429	Janith Asheka	2005.04.15

Table 9.28 - Sports Table

<u>Sport No</u>	Sport	Number of permanant Members
S001	Cricket	11
S002	Football	16
S003	Volleyball	6

Many-to-many relationship between Student Table and Sports Table is converted to one-to-many relationships in related databases. For this, another table is needed apart from the two tables given above. (Let us name that table as Student_Sports Table – Table 9.30) Let us include Admission Number of Student table and Sport_No of Sport table to Students_Sport table.

Table 9.29 - Student Table

Admission No	Name	Date of Birth
1426	Kavindu Prabashwara	2005.05.23
1428	Mohommad Malikkar	2005.02.07
1429	Janith Asheka	2005.04.15

Table 9.30 - Student_Sport Table

<u>Admission No</u>	<u>Sport No</u>	Team
1426	S001	A
1426	S002	A
1428	S001	B
1428	S002	A
1428	S003	B
1429	001	A
1429	S003	A

Table 9.31 - Sports Table

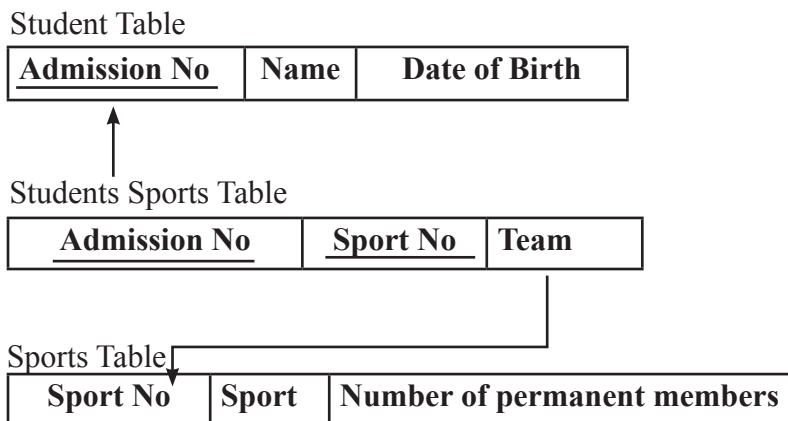
<u>Sport No</u>	Sport	Number of permanent members
S001	Cricket	11
S002	Football	16
S003	Volleyball	6

The Admission Number is the Primary key of the Student Table and the foreign key of Students_Sports Table.

The Sport Number is the primary key of the Sports Table and the foreign key of Students_Sports Table.

The primary key of the Students_Sports Table is Admission Number + Sport Number.

When establishing a many-to-many relationship, a new table must be created. The primary keys of the two original tables are included in this new table as foreign keys to create the relationship. Furthermore, if there are any fields common to both tables, they can also be included in the new table.



Refer Figure 9.13 which gives relationship when two tables like the Student Table and Sports Table with many-to-many relationships are converted to one-to-many relationships.

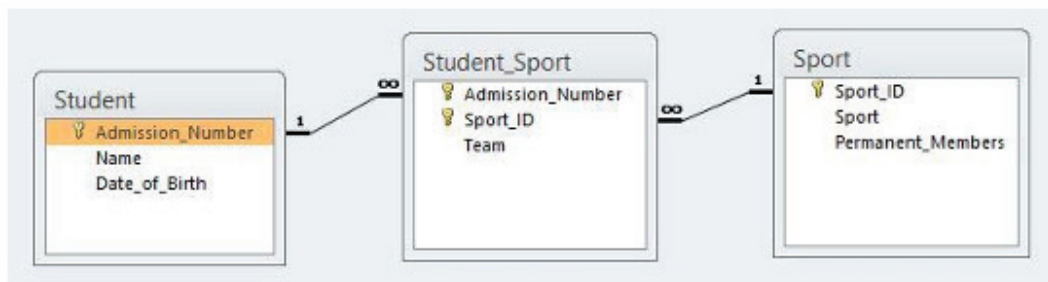


Figure 9.12 - Many-to-Many Relationship

Thus,

There is a one-to-many relationship between the Student Table and the Student_Sport Table.

There is a one-to-many relationship between Sports Table and Student_Sport Table.

Hence, by using an extra table, many-to-many relationships can be converted to one-to-many relationships.

9.5 Creating a Relational Database Using Database Management System Software

Follow the steps below when creating a relational database:

1. Design and create the table.
2. Assign the primary key.
3. Create relationships between the tables.
4. Design forms for data entry.
5. Enter the data.
6. Retrieve information using queries.

Let us learn how to build relationships between tables using a Database Management System software. For this, create the tables given below: Figure 9.13 – Student Table (using field names and data types given) and Figure 9.14 – Marks Table.

Student	
Field Name	Data Type
Admission_Number	Text
Surname_with_Initials	Text
Date_of_Birth	Date/Time
Telephone_Number	Text
Admission_Fees	Currency

Figure 9.13 – Field names and data types of Student Table

Marks	
Field Name	Data Type
Index_Number	Text
Admission_Number	Text
Maths	Number
Science	Number
English	Number
Year	Text

Figure 9.14 – Field names and data types of marks table

9.5.1 Buildup relationship between tables

For Microsoft Office Access...

Select Database Tools → Select Relationship command → Select Show table → Select the table which should be related → Click 'Add' command button. (Indicate the number of tables required) → Drag the Primary Key to the foreign key of the table which should be related (Figure 9.15) → Select 'Enforce Referential Integrity' on 'Edit Relationship' Dialogue Box (Refer 9.16) → Select 'Cascade Update Related Field' and 'Cascade Update Related Records' → Click 'Create' command button.

For LibreOffice...

Select Tools Menu → Select Relationship command → Select the table which should be related → Click Add command button. (Indicate the number of tables required) → Drag the Primary Key to the foreign key of the table which should be related → Right click on Relationship and select Edit → Select 'Update Cascade' under 'Update Option' on Relations Dialogue Box. Select 'Delete Cascade' under 'Delete Option' (Figure 9.17) → Click 'OK' command button.

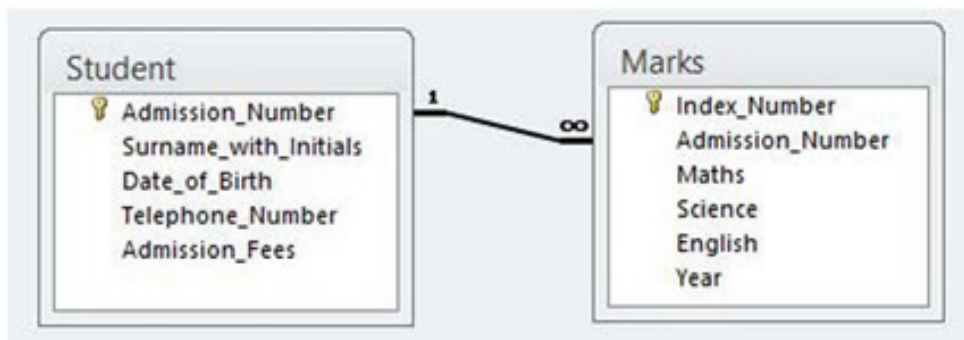


Figure 9.15 - One-to-many relationship between two tables.

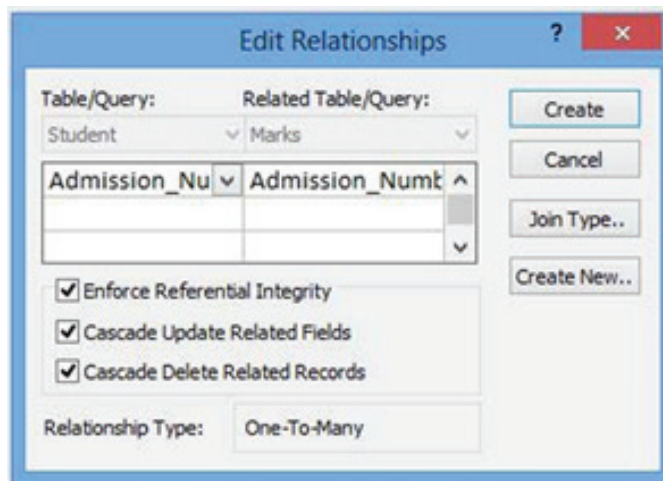


Figure 9.16 – Editing Relationship Dialogue Box (Access)

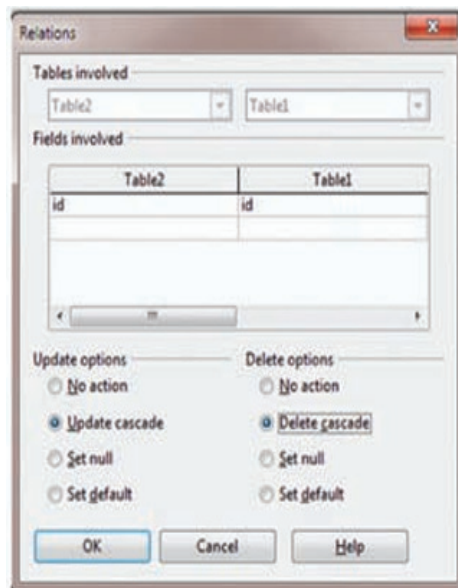


Figure 9.17 – A Relations Dialogue Box (LibreOffice Base)

Admission_Number is the primary key of the student table and foreign key of the Marks Table.

observation



Special Features in Related Tables

As soon as the values of a primary key field of the student Table are updated using 'Referential Integrity,' the foreign key field values of the related table are automatically changed.

Further, when a record of the Student Table is deleted, the related records of the related table are automatically deleted.

First, data should be entered to the student Table. After that, data can be entered to the Marks Table.

After entering the data to the Student Table, data can be entered to the Marks Table through it.

For this, click on the + mark which is in front of the Admission Number of the Student Table. Then data can be entered to Marks Table easily. (Refer Figure 9.18)

Student						
Admission Number	Surname with Initials	Date of Birth	Telephone Number	Admission Fees		
001	Karunajeewa R.J.C	8/10/2003	0715648453	Rs. 560.00		
+	Index Numl	Maths	Science	English	Year	Click to Add
	1001	67	45	78	2013	
	1101	56	64	51	2014	
+	002	Somarathna A.B.G.	3/1/2003	0777876514	Rs. 560.00	
+	003	Rasaputhram S.N.	7/10/2003	0346737785	Rs. 560.00	
+	+	Index Numl	Maths	Science	English	Year
		1003	37	54	35	2013
		1103	68	60	72	2014
+	004	Jayasena L.K.R.	7/11/2003	0112356567	Rs. 560.00	
+	005	Malikkar M.N.M.	9/23/2003	0727543627	Rs. 560.00	
+	006	Radhakrisna T.U.	1/6/2003	0679734355	Rs. 560.00	
+	007	Faslina M.G.	3/27/2003	0417878676	Rs. 560.00	

Figure 9.18 – Entering data to Student Table and Marks Table.

9.6 Creating Forms to Entering and Displaying Data

Now you have knowledge about creating a table and entering data to it. Forms are used to enter data to a table in Database Management Systems. Further, forms are used to display entered data as well.

Data Table

Name	Address	Telephone No	Email
Anwar	Athurugiriya	0773684949	anvmom@dd.uk
Nimal	Galewela	07184632481	nigl@ya.com
Sudakaran	Kandy	0817587484	suda@gmail.com
saman	Kegalle		

Figure 9.19 Table and Data From

A form for data input with fields for Name, Address, Telephone No, and Email. The Name field contains 'Saman' and the Address field contains 'Kegalle'. The Telephone No and Email fields are empty.

Data input through from

A form for data display with fields for Name, Address, Telephone No, and Email. The Name field contains 'Nimal', the Address field contains 'Galewela', the Telephone No field contains '07184637481', and the Email field contains 'nigl@ya.com'.

Display data on from

Each input record is entered to the last row of the table. Each record of the table can be filled one by one through the form. For this, the Record Navigation Bar of a form is used. (Refer Figure 9.20)

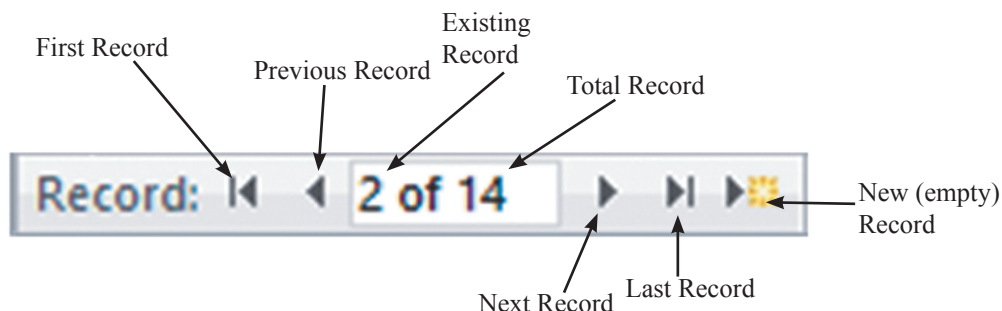


Figure 9.20 – Checking records from a data form.

1. Building a Data Form

For Microsoft Office Access...

Create → Form Design → Add Existing Fields → Show tables → Select the required table
→ Drag table fields to the form (Refer Figure9.21)

Admission Number	Admission_Number
Surname with Initials	Surname_with_Initials
Date of Birth	Date_of_Birth
Telephone Number	Telephone_Number
Admission Fees	Admission_Fees
Add New Record	Delete Record

Figure 9.21 - Data form to enter data to the student Table

2. Showing Table Records in Data Form

For Microsoft Office Access...

Home Tab → View → Form view (Refer Figure9.22)

Admission_Number	001
Surname_with_Initials	Karunajeewa R.J.C.
Date_of_Birth	8/10/2003
Telephone_Number	0715648453
Admission_Fees	Rs. 560.00
Add New Record	Delete Record

Figure 9.22 - Showing records in the Student Table

3. Entering control Wizards to a Form

For Microsoft Office Access...

Design Tab → Select 'Control Wizards' (Refer Figure 9.23) → Select the button indicated as xxxx → Establish the button in data form → Select Record Operation in Command Button Wizard (Refer Figure 9.24) → Select the Action which should be entered (E.g. : Add New Record) → Give a proper name to the button → Finish



Figure 9.23 - Controlling Tools

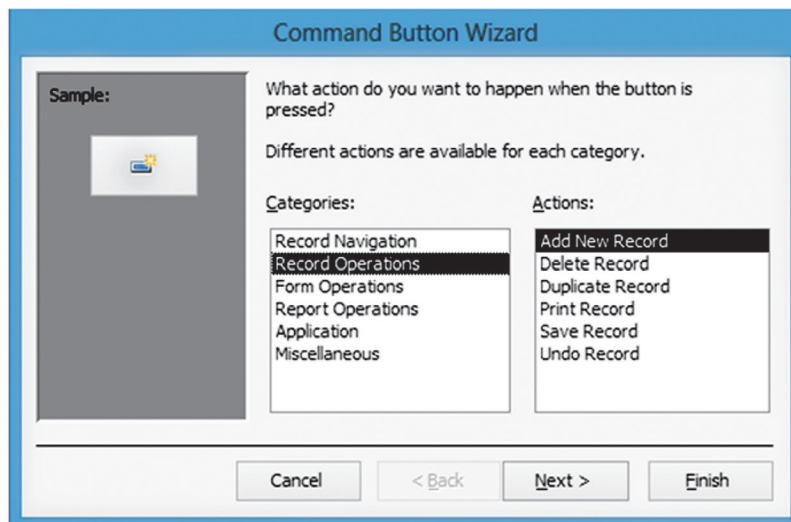


Figure 9.24 Command Button Wizard

9.7 Designing Query to Get Information

Let us use query to obtain necessary information from the data of related tables. Query represents data of selected fields (columns) in each table. (Refer Figure 9.25)

Student No	Name	Email
A1	Pubudu	Pu2@gmail.com
A2	Fairs	pari@yahoo.com
A3	Kamalan	Kam_n@hotmail.com
A4	Thanuja	Thanu7@slt.lk

Subject No	Subject
B1	Maths
B2	Science
B3	English

Student No	Subject No	Marks
A1	B1	67
A2	B3	89
A1	B3	50
A3	B2	75

When Name, Subject and Marks are taken by a query from the three table above.

Name	Subject	Marks
Pubudu	Maths	67
Faris	English	89
Pubudu	English	50
Kamalan	Science	75

Figure 9.25 - Obtaining data to a query

Designing a Query

For Microsoft OfficeAccess

Create Tab → Query Design → Select the necessary tables (Refer Figure 9.26) → Select the necessary field from the table (Refer Figure 9.27) → Run the query →

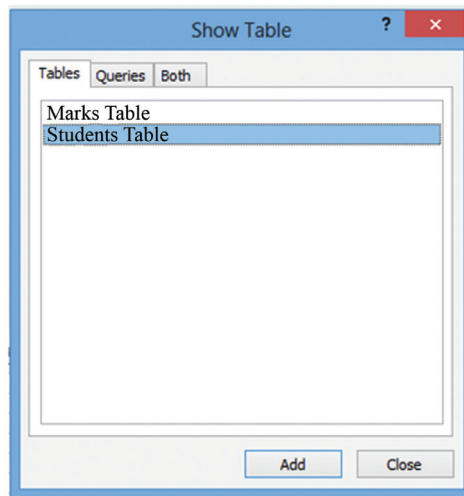


Figure 9.26 - Dialogue Box to select tables

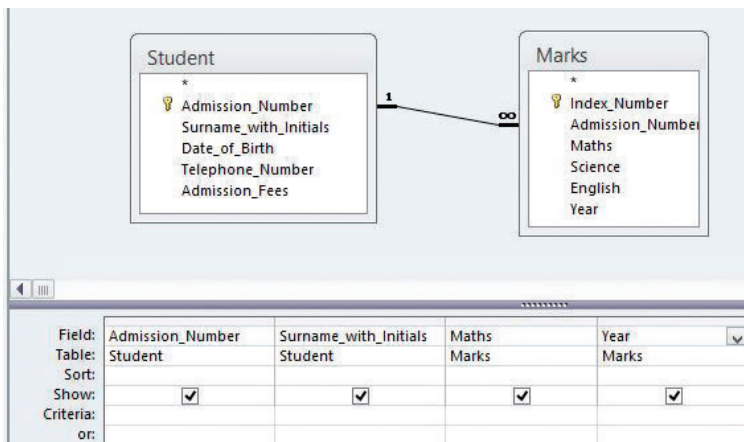


Figure 9.27 – Window to design query

Refer figure 9.28 given below for the information received after running the query.

Admission_Number	Surname_with_Initials	Maths	Year
001	Karunajeewa R.J.C	67	2013
001	Karunajeewa R.J.C	56	2014
002	Somarathna A.B.G.	76	2013
002	Somarathna A.B.G.	66	2014
003	Rasaputhram S.N.	37	2013
003	Rasaputhram S.N.	68	2014
004	Jayasena L.K.R.	87	2013
004	Jayasena L.K.R.	92	2014
005	Malikkar M.N.M.	62	2013
005	Malikkar M.N.M.	76	2014
006	Radhakrisna T.U.	32	2013
006	Radhakrisna T.U.	43	2014
007	Faslina M.G.	70	2013
007	Faslina M.G.	80	2014

Figure 9.28 - Information received after running the query

As shown in Figure 9.28, marks scored by students in 2013 and 2014 are shown.

You can obtain marks scored by students in 2014 only (information shown in Figure 9.28) by naming year 2014 as Criteria. (Refer Figure 9.29)

Field:	Admission_Number	Surname_with_Initials	Maths	Year
Table:	Student	Student	Marks	Marks
Sort:				
Show:	☒	☒	☒	☒
Criteria:				2014*
or:				

Figure 9.29 - Giving Criteria for query

Admission_Number	Surname_with_Initials	Maths	Year
001	Karunajeewa R.J.C	56	2014
002	Somarathna A.B.G.	66	2014
003	Rasaputhram S.N.	68	2014
004	Jayasena L.K.R.	92	2014
005	Malikkar M.N.M.	76	2014
006	Radhakrisna T.U.	43	2014
007	Faslina M.G.	80	2014

Figure 9.30 - Information received after running query with Criteria

Various calculations can be made using fields through query. Let us learn how total marks scored by students are calculated.

Add a new column to the query as Total and build an expression indicating the calculation needed. To get total marks of subject it should be typed as:

Total: [Marks]![Maths]+[Marks]![Science]+[Marks]![English]. This can be typed (Refer Figure 9.31.) or can be performed by building the expression, right click the Mouse button on the column which you expect to get the total and select Build command. Then use the Dialogue Box you get. (Refer Figure 6.32)

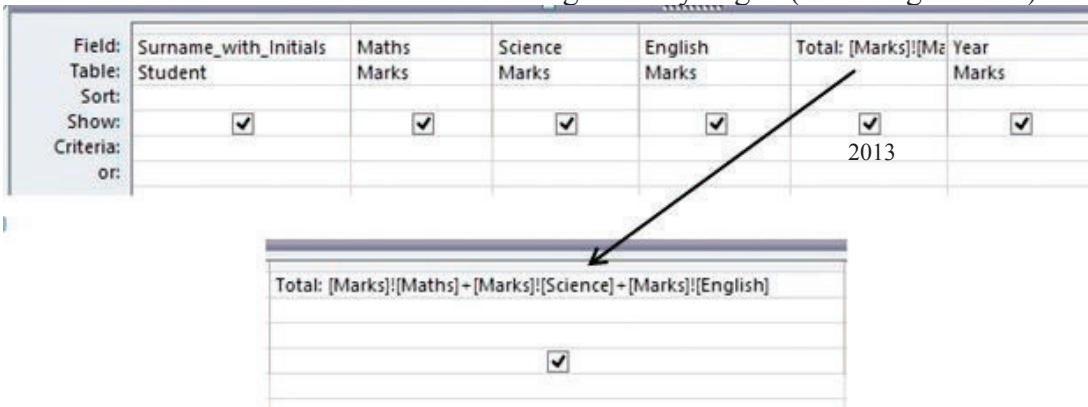


Figure 9.31 – Enlarge 'Total' column in the query

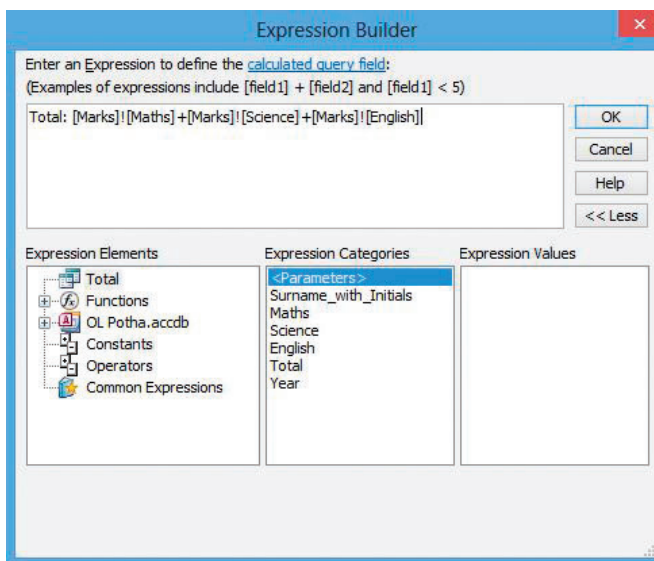


Figure 9.32 – Dialogue Box to build the expression

After running the query built in the way explained above, you get information as given in Figure 9.33 which is given below.

Index_Number	Surname_with_Initials	Maths	Science	English	Total	Year
1001	Karunajeewa R.J.C	67	45	78	190	2013
1002	Somarathna A.B.G.	76	81	55	212	2013
1003	Rasaputhram S.N.	37	54	35	126	2013
1004	Jayasena L.K.R.	87	72	68	227	2013
1005	Malikkar M.N.M.	62	56	43	161	2013
1006	Radhakrisna T.U.	32	45	65	142	2013
1007	Faslina M.G.	70	89	65	224	2013
*						

Figure 9.33 - Marks and total of students scored in 2013

9.8 Designing Reports to Present Information

Reports are used to obtain printed copies of important information received from the data of related tables. Both tables and queries can be used to design reports.

Let us learn how a report is designed using the query given above in Figure 9.33.

Report Wizard can be used to design reports.

For Microsoft Office Access

Create Tab → Report Wizard → Select the necessary table or query (Refer Figure 9.34) → Select the fields needed for the report from the table or query → Design the report as you need clicking Next button → Finish Then you will get a report as shown in Figure 9.35

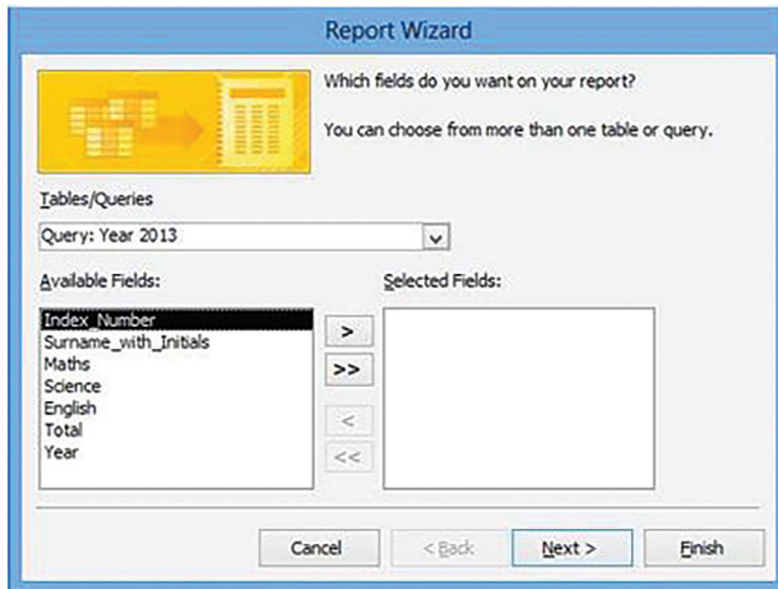


Figure 9.34 - Report Wizard used to design reports

Marks						
Index_Number	Surname_with_Initials	Maths	Science	English	Total	Year
1001	Karunajeewa R.J.C	67	45	78	190	2013
1002	Somarathna A.B.G.	76	81	55	212	2013
1003	Rasaputhram S.N.	37	54	35	126	2013
1004	Jayasena L.K.R.	87	72	68	227	2013
1005	Malikkar M.N.M.	62	56	43	161	2013
1006	Radhakrisna T.U.	32	45	65	142	2013
1007	Faslina M.G.	70	89	65	224	2013

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Figure 9.35 - Report which displays the total marks of students in 2013

Let us learn how numerical values included in a report are calculated.

For this, let us find the total of admission fees paid by the students. Create a report as explained above using Report Wizard including Admission Number, Name and Admission Fees. Then change from Report View to Design View. Then you will get a report layout as shown in Figure 9.36.

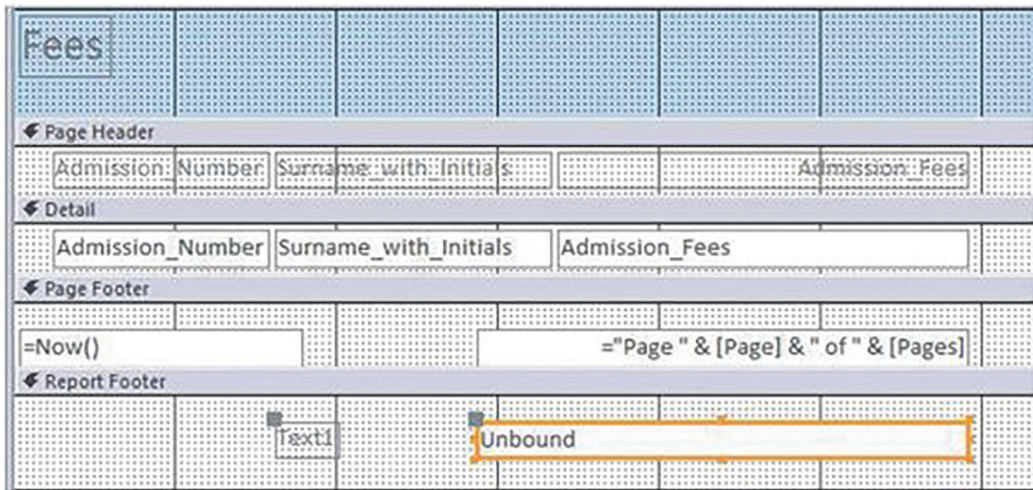


Figure 9.36 - Report plan

Select the tool given as 'ab' on the tool bar and establish the text box under Report Footer. (Refer Figure 9.37)

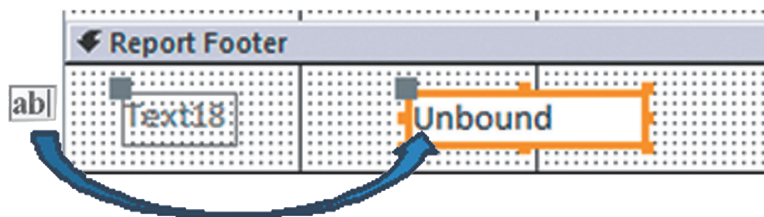


Figure 9.37 - Establishing the text box

The text box is indicated as unbound. The reason for this is there is no field given to it. To get the total of admission fees, get the Expression Builder Dialogue Box to build expressions by clicking the button with three dots in front of the Control Source on Property Sheet. (Refer Figure 9.38)

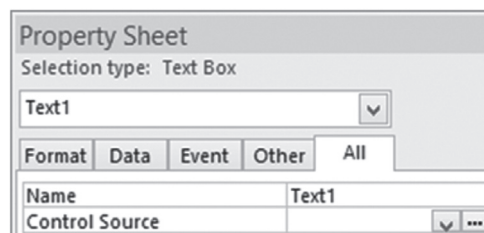


Figure 9.38- Property Sheet

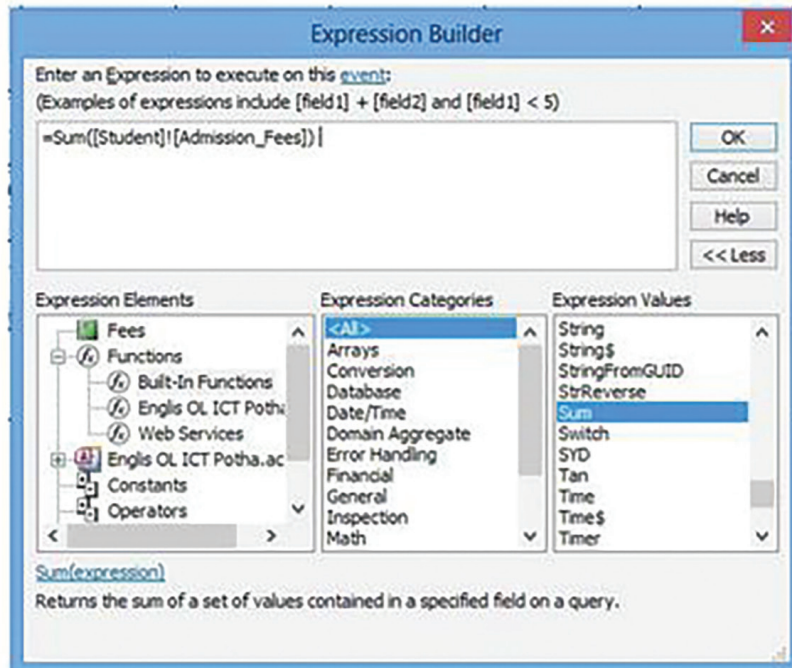


Figure 9.39 – Expression Builder Dialogue Box

To get the total of admission fees, type the expression = Sum ([Student Table]![Admission Fees]) and type OK. Then change the view from Design View to Report View. After that, you will get the report which displays the total of Admission Fees. (Refer Figure 9.40)

Fees		
Admission_Number	Surname_with_Initials	Admission_Fees
001	Karunajeewa R.J.C.	Rs. 560.00
002	Somarathna A.B.G.	Rs. 560.00
003	Rasaputhram S.N.	Rs. 560.00
004	Jayasena L.K.R.	Rs. 560.00
005	Malikkar M.N.	Rs. 560.00
006	Radhakrisna T.U.	Rs. 560.00
007	Faslina M.G.	Rs. 560.00
Total		Rs. 3,920.00

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Figure 9.40 - Report which displays the total of Admission Fees

Printing the Report

Change the 'Report view' to 'Print Preview'. Click on the tool shown in Figure 9.41. Print the number of copies you need.

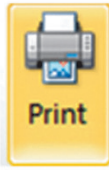


Figure 9.41 - printing tool

Activity



1. Explain the advantages of electronic databases.
2. Explain with examples the features that are available in electronic databases.
3. Compare electronic and manual database.
4. Explain what is meant by data encryption is.
5. Explain relational databases using fields, records and tables.
6. Define primary key and provide three examples.
7. Define composite key and provide three examples.
8. Define foreign key with three examples.
9. Write five disadvantages of data duplication.
10. a) What is a data type? Provide examples for data types.
b) Explain the reason as to why 'integer' data type is not the best data type for field that stores telephone numbers.
11. Explain the relationships; one-to-one, one-to-many and many-to-many with two examples for each.
12. Explain what 'objects' are in Database Management Systems and explain the uses of the objects.

Summary

- Database is defined as the collection of organized data.
- In a table a column is known as a 'Field'
- A row of a table is known as a 'Record'
- Advantages of electronic database
 - Efficient in searching data.
 - Facilities to get copies.
 - Less storage capacity used for storing data.
 - Efficient analysis of data.
 - Sharing data.
 - Data independence.
- Characteristic of a database.
 - Avoid data redundancy.
 - Consistency of data.
 - Increased efficiency
 - Increased accuracy
 - Increased validity
 - Increase the security of data.
- A column or collection of columns in a table when records can be identified uniquely is called primary key.
- If a field (or a combination of fields) of one table can be used to uniquely identify rows in another table, these fields are called the foreign keys.
- A relationship is built up between two tables by using foreign key.
- Data redundancy means the same data is stored in several database tables.
- The type of data that is relevant to a field is known as data type.
- In a relational database a relationships such as one-to-one, one-to-many and many-to-many can be exist.
- To enter and display data, forms can be used.
- Query is used to obtain information.
- To present data, reports are used.