

King Saud University
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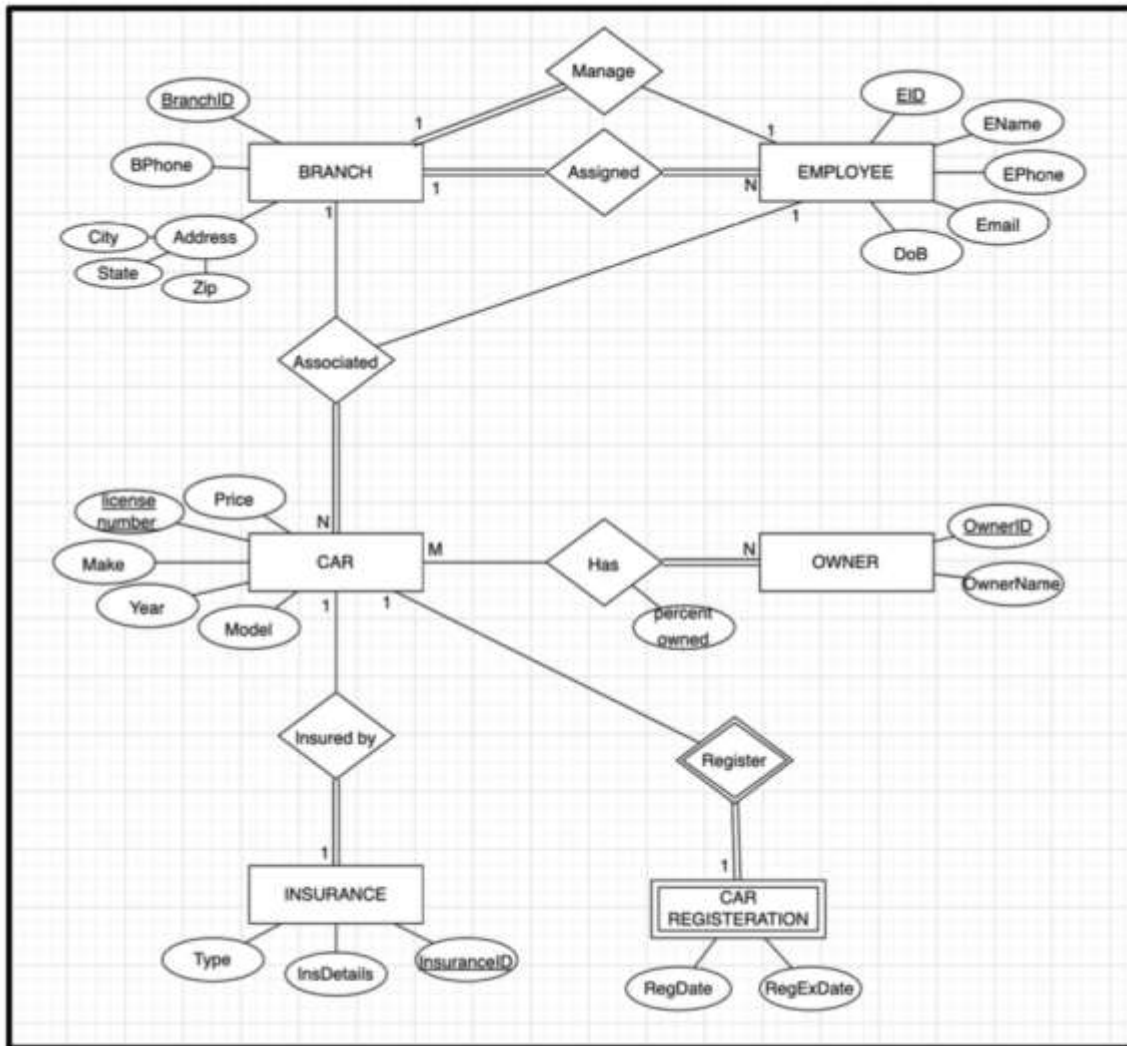
IS230: Introduction to Database Systems
2nd Semester

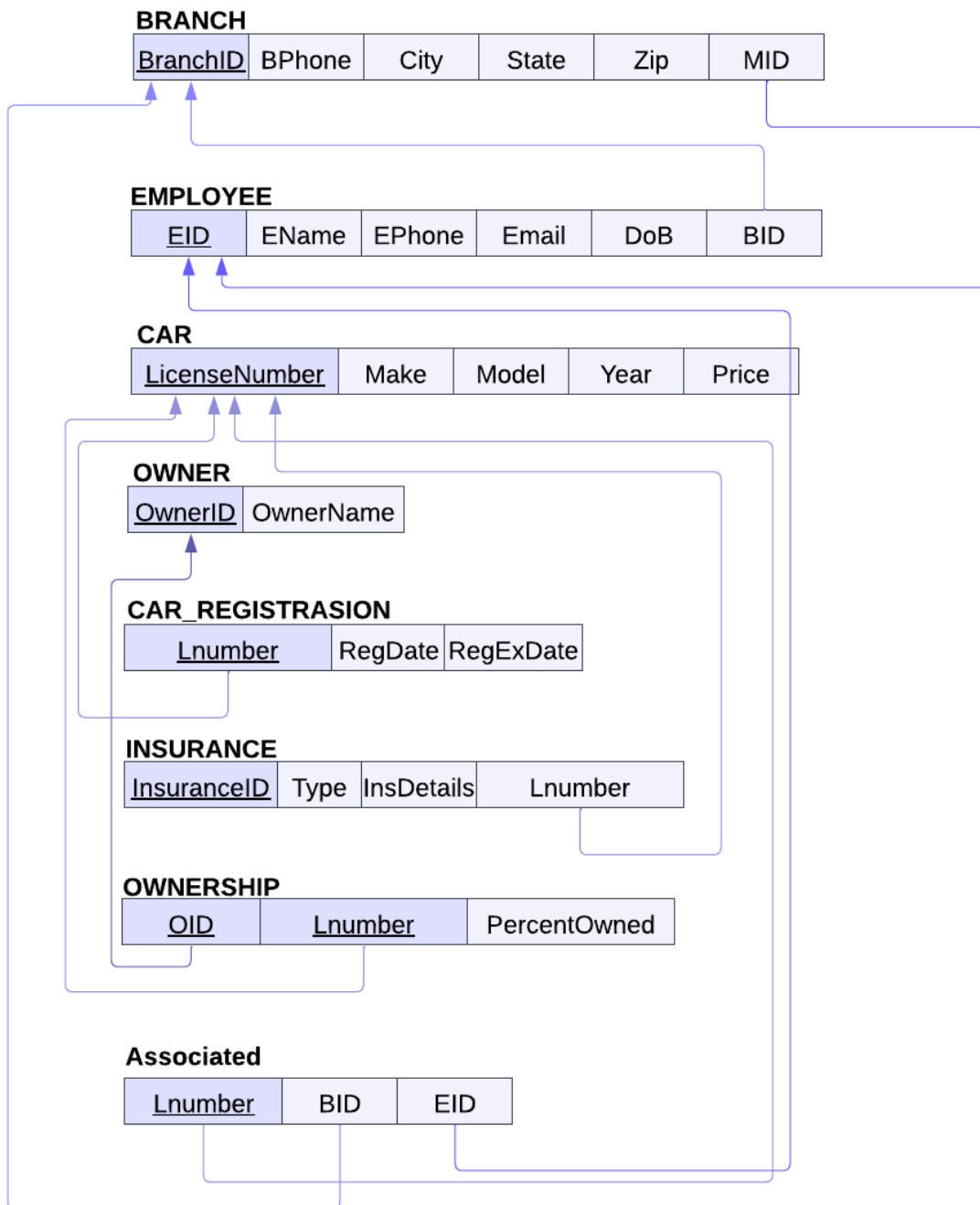


Car Dealership Management Database System | Phase 2

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Step 1: Mapping of Regular Entity Types.

Regular entities have a primary key that uniquely identifies each entity instance.

- BRANCH `(BranchID, BPhone, City, State, Zip)` - `BranchID` is the primary key.
- EMPLOYEE `(EID, EName, EPhone, Email, DoB)` - `EID` is the primary key.
- OWNER `(OwnerID, OwnerName)` - `OwnerID` is the primary key.
- CAR `(LicenseNumber, Make, Model, Year, Price)` - `LicenseNumber` is the primary key.
- INSURANCE `(InsuranceID, Type, InsDetails)` - `InsuranceID` is the primary key.

Step 2: Mapping of Weak Entity Types

Weak entities do not have a primary key and are existence-dependent on a strong entity, often with a partial key.

- CAR_REGISTRATION `(Lnumber, RegDate, RegExDate)` - It is a weak entity because its existence is dependent on the `CAR`. Lnumber becomes a foreign key AND primary key.

Step 3: Mapping of Binary 1:1 Relation Types.

In the case of the two 1:1 relationships from the ER diagram:

1. Manage Relationship (BRANCH to EMPLOYEE):

Since every branch is managed by exactly one employee (total participation of BRANCH), and not every employee is a manager (partial participation of EMPLOYEE), the foreign key referencing EMPLOYEE is placed in the BRANCH table. This ensures that every branch record has a valid manager's identifier, and there are no NULL values for the foreign key in the BRANCH table.

2. Insured by Relationship (CAR to INSURANCE)

Since INSURANCE has total participation, we will add the primary key of CAR to it as a foreign key to indicate relationship and this assures less frequent NULL values.

Step 4: Mapping of Binary 1:N Relationship Types

A binary 1:N relationship type represents a relationship where each entity from one entity set (the "one" side) is associated with multiple entities from another entity set (the "many" side), but each entity from the "many" side is associated with only one entity from the "one" side.

The "Associated" relation is mapped into ASSOCIATED relation with one primary key Lnumber as foreign key too, and two weak attributes "BID" and "EID".

Step 5: Mapping of Binary M:N Relationship Types.

M-N are mapped as a new relation with the primary key being the combination of both and as foreign keys as well,

The "HAS" relation is mapped into OWNERSHIP relation with two Primary keys Lnumber and OID and as foreign keys too, the PercentOwned is added to the relation too

Step 6: Mapping of Multivalued attributes.

There do not appear to be multivalued attributes in the ER diagram, so we can skip this step.

Step7: Mapping of N-ary Relationship Types.

The Ternary relationship Associated is mapped into its own relation with 3 foreign keys and a single Primary key.

Why a single primary key? Because the other two participating entities have cardinality of 1.

From these steps, we create a set of relational tables that implement the structure of the ER diagram in a relational database.

SQL script to generate the Database:

```
CREATE DATABASE Velocity_Motors;
```

```
USE Velocity_Motors;
```

```
CREATE TABLE Employee (  
    EID INT PRIMARY KEY,  
    EName VARCHAR(100) NOT NULL,  
    EPhone VARCHAR(10) NOT NULL,  
    Email VARCHAR(100) NOT NULL,  
    DoB DATE,  
    BID INT  
);
```

```
CREATE TABLE Branch (  
    BranchID INT PRIMARY KEY,  
    BPhone VARCHAR(10) NOT NULL,  
    City VARCHAR(20) NOT NULL,  
    State VARCHAR(20) NOT NULL,  
    Zip VARCHAR(10),  
    MID INT  
);
```

```
CREATE TABLE Car (  
    LicenseNumber VARCHAR(15) PRIMARY KEY,  
    Make VARCHAR(50) NOT NULL,  
    Model VARCHAR(50) NOT NULL,  
    Year YEAR,  
    Price DECIMAL(10, 2) NOT NULL,  
    BID INT,  
    EID INT  
);
```

```
CREATE TABLE Owner (  
    OwnerID INT PRIMARY KEY,  
    OwnerName VARCHAR(100) NOT NULL  
);
```

```
CREATE TABLE CarRegistration (  
    Lnumber VARCHAR(15) NOT NULL,  
    RegDate DATE NOT NULL,  
    RegExDate DATE NOT NULL,  
    PRIMARY KEY (Lnumber)  
);
```

```
CREATE TABLE Insurance (  
    InsuranceID INT PRIMARY KEY,  
    Type VARCHAR(50) NOT NULL,  
    InsDetails VARCHAR(100),  
    Lnumber VARCHAR(15)  
);
```

```
CREATE TABLE Ownership (  
    OID INT NOT NULL,  
    Lnumber VARCHAR(15) NOT NULL,  
    PercentOwned DECIMAL(5, 2) NOT NULL,  
    PRIMARY KEY (OID, Lnumber)  
);
```

```
CREATE TABLE Associated (  
    BID INT NOT NULL,  
    EID INT NOT NULL,  
    Lnumber VARCHAR(15) NOT NULL,  
    PRIMARY KEY (Lnumber)  
);
```

```

-- Adding foreign key relationships with CASCADE options
ALTER TABLE Branch ADD CONSTRAINT FK_BranchManager
    FOREIGN KEY (MID) REFERENCES Employee(EID)
    ON DELETE RESTRICT ON UPDATE CASCADE;

ALTER TABLE Employee ADD CONSTRAINT FK_EmployeeBranch
    FOREIGN KEY (BID) REFERENCES Branch(BranchID)
    ON DELETE CASCADE ON UPDATE CASCADE;

ALTER TABLE CarRegistration ADD CONSTRAINT FK_CarRegistrationCar
    FOREIGN KEY (Lnumber) REFERENCES Car(LicenseNumber)
    ON DELETE CASCADE ON UPDATE CASCADE;

ALTER TABLE CarRegistrasion ADD CONSTRAINT CHK_RegDate
    CHECK (RegDate < RegExDate);

ALTER TABLE Insurance ADD CONSTRAINT FK_InsuranceCar
    FOREIGN KEY (Lnumber) REFERENCES Car(LicenseNumber)
    ON DELETE CASCADE ON UPDATE CASCADE;

ALTER TABLE Ownership ADD CONSTRAINT FK_OwnershipOwner
    FOREIGN KEY (OID) REFERENCES Owner(OwnerID)
    ON DELETE CASCADE ON UPDATE CASCADE;

ALTER TABLE Ownership ADD CONSTRAINT FK_OwnershipCar
    FOREIGN KEY (Lnumber) REFERENCES Car(LicenseNumber)
    ON DELETE CASCADE ON UPDATE CASCADE;

ALTER TABLE Associated ADD CONSTRAINT FK_AssociatedBranch
    FOREIGN KEY (BID) REFERENCES Branch(BranchID)
    ON DELETE CASCADE ON UPDATE CASCADE;

ALTER TABLE Associated ADD CONSTRAINT FK_AssociatedEmployee
    FOREIGN KEY (EID) REFERENCES Employee(EID)
    ON DELETE CASCADE ON UPDATE CASCADE;

ALTER TABLE Associated ADD CONSTRAINT FK_AssociatedCar
    FOREIGN KEY (Lnumber) REFERENCES Car(LicenseNumber)
    ON DELETE CASCADE ON UPDATE CASCADE;

```

Assumptions and Notes:

- Assumed NOT NULL as we saw to be the best fit.
- **CASCADE** options for `CarRegistration`, `Insurance`, and `Ownership` ensure that the database automatically maintains consistency by removing all dependent data when a `Car` or `Owner` is removed, reflecting the real-world scenario where such dependent records are no longer relevant without their parent record.
- **SET NULL** for the `Car` to `Employee` relationship allows for the retention of `Car` records even if the associated `Employee` is no longer present, acknowledging that cars can exist without being tied to an employee.
- **CASCADE** for updates across all foreign keys ensures that the database remains consistent even if primary keys change, though primary key changes are rare in well-designed databases.

Maria DB Screenshots:

1- Create Database

```
MariaDB [(none)]> CREATE DATABASE Velocity__Motors;
Query OK, 1 row affected (0.001 sec)

MariaDB [(none)]> SHOW DATABASES;
+-----+
| Database |
+-----+
| cardealership |
| information_schema |
| mysql |
| performance_schema |
| sys |
| velocity__motors |
| velocity_motors |
| velocitymotors |
+-----+
8 rows in set (0.001 sec)
```


2- Create Employee Table

```
MariaDB [(none)]> USE Velocity_Motors;
Database changed
MariaDB [Velocity_Motors]> CREATE TABLE Employee (
  ->     EID INT PRIMARY KEY,
  ->
  ->     EName VARCHAR(100) NOT NULL,
  ->
  ->     EPhone VARCHAR(10) NOT NULL,
  ->
  ->     Email VARCHAR(100) NOT NULL,
  ->
  ->     DoB DATE,
  ->
  ->     BID INT
  -> );
Query OK, 0 rows affected (0.007 sec)
```

```
MariaDB [Velocity_Motors]> DESC Employee;
```

Field	Type	Null	Key	Default	Extra
EID	int(11)	NO	PRI	NULL	
EName	varchar(100)	NO		NULL	
EPhone	varchar(10)	NO		NULL	
Email	varchar(100)	NO		NULL	
DoB	date	YES		NULL	
BID	int(11)	YES		NULL	

```
6 rows in set (0.008 sec)
```

3- Create Branch Table

```
MariaDB [Velocity_Motors]> CREATE TABLE Branch (
  -> BranchID INT PRIMARY KEY,
  -> BPhone VARCHAR(10) NOT NULL,
  -> City VARCHAR(20) NOT NULL,
  -> State VARCHAR(20) NOT NULL,
  -> Zip VARCHAR(10),
  -> MID INT
  -> );
Query OK, 0 rows affected (0.008 sec)
```

```
MariaDB [Velocity_Motors]> DESC Branch;
```

Field	Type	Null	Key	Default	Extra
BranchID	int(11)	NO	PRI	NULL	
BPhone	varchar(10)	NO		NULL	
City	varchar(20)	NO		NULL	
State	varchar(20)	NO		NULL	
Zip	varchar(10)	YES		NULL	
MID	int(11)	YES		NULL	

```
6 rows in set (0.009 sec)
```

4- Create Car Table

```

MariaDB [Velocity__Motors]> CREATE TABLE Car (
->
->   LicenseNumber VARCHAR(15) PRIMARY KEY,
->
->   Make VARCHAR(50) NOT NULL,
->
->   Model VARCHAR(50) NOT NULL,
->
->   Year YEAR,
->
->   Price DECIMAL(10, 2) NOT NULL,
->
->   BID INT,
->
->   EID INT
-> );
Query OK, 0 rows affected (0.009 sec)

MariaDB [Velocity__Motors]> DESC Car;
+-----+-----+-----+-----+-----+-----+
| Field | Type | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| LicenseNumber | varchar(15) | NO | PRI | NULL | |
| Make | varchar(50) | NO | | NULL | |
| Model | varchar(50) | NO | | NULL | |
| Year | year(4) | YES | | NULL | |
| Price | decimal(10,2) | NO | | NULL | |
| BID | int(11) | YES | | NULL | |
| EID | int(11) | YES | | NULL | |
+-----+-----+-----+-----+-----+-----+
7 rows in set (0.007 sec)

```

5- Create Owner Table

```

MariaDB [Velocity__Motors]> CREATE TABLE Owner (
->
->   OwnerID INT PRIMARY KEY,
->
->   OwnerName VARCHAR(100) NOT NULL
-> );
Query OK, 0 rows affected (0.006 sec)

MariaDB [Velocity__Motors]> DESC Owner;
+-----+-----+-----+-----+-----+-----+
| Field | Type | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| OwnerID | int(11) | NO | PRI | NULL | |
| OwnerName | varchar(100) | NO | | NULL | |
+-----+-----+-----+-----+-----+-----+
2 rows in set (0.008 sec)

```

6- Create CarRegistration Table

```

MariaDB [Velocity__Motors]> CREATE TABLE CarRegistration (
->
->   Lnumber VARCHAR(15) NOT NULL,
->
->   RegDate DATE NOT NULL,
->
->   RegExDate DATE NOT NULL,
->
->   PRIMARY KEY (Lnumber)
-> );
Query OK, 0 rows affected (0.006 sec)

MariaDB [Velocity__Motors]> DESC CarRegistration;
+-----+-----+-----+-----+-----+-----+
| Field | Type | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| Lnumber | varchar(15) | NO | PRI | NULL | |
| RegDate | date | NO | | NULL | |
| RegExDate | date | NO | | NULL | |
+-----+-----+-----+-----+-----+-----+
3 rows in set (0.008 sec)

```

7- Create Insurance Table

```

MariaDB [Velocity__Motors]> CREATE TABLE Insurance (
->
->   InsuranceID INT PRIMARY KEY,
->
->   Type VARCHAR(50) NOT NULL,
->
->   InsDetails VARCHAR(100),
->
->   Lnumber VARCHAR(15)
-> );
Query OK, 0 rows affected (0.018 sec)

MariaDB [Velocity__Motors]> DESC Insurance;
+-----+-----+-----+-----+-----+-----+
| Field | Type | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| InsuranceID | int(11) | NO | PRI | NULL | |
| Type | varchar(50) | NO | | NULL | |
| InsDetails | varchar(100) | YES | | NULL | |
| Lnumber | varchar(15) | YES | | NULL | |
+-----+-----+-----+-----+-----+-----+
4 rows in set (0.009 sec)

```

8- Create OwnerShip Table

```

MariaDB [Velocity_Motors]> CREATE TABLE Ownership (
->
->   OID INT NOT NULL,
->
->   Lnumber VARCHAR(15) NOT NULL,
->
->   PercentOwned DECIMAL(5, 2) NOT NULL,
->
->   PRIMARY KEY (OID, Lnumber)
-> );
Query OK, 0 rows affected (0.007 sec)

MariaDB [Velocity_Motors]> DESC Ownership;
+-----+-----+-----+-----+-----+-----+
| Field | Type      | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| OID   | int(11)   | NO   | PRI | NULL    |       |
| Lnumber | varchar(15) | NO   | PRI | NULL    |       |
| PercentOwned | decimal(5,2) | NO   |     | NULL    |       |
+-----+-----+-----+-----+-----+-----+
3 rows in set (0.008 sec)

```

9- Create Associated Table

```

MariaDB [Velocity_Motors]> CREATE TABLE Associated (
->
->   BID INT NOT NULL,
->
->   EID INT NOT NULL,
->
->   Lnumber VARCHAR(15) NOT NULL,
->
->   PRIMARY KEY (Lnumber)
-> );
Query OK, 0 rows affected (0.005 sec)

MariaDB [Velocity_Motors]> DESC Associated;
+-----+-----+-----+-----+-----+-----+
| Field | Type      | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| BID   | int(11)   | NO   |     | NULL    |       |
| EID   | int(11)   | NO   |     | NULL    |       |
| Lnumber | varchar(15) | NO   | PRI | NULL    |       |
+-----+-----+-----+-----+-----+-----+
3 rows in set (0.008 sec)

```

10- Constraints and foreign keys

```

MariaDB [Velocity_Motors]> ALTER TABLE Branch ADD CONSTRAINT FK_BranchManager
->
->   FOREIGN KEY (MID) REFERENCES Employee(EID)
->
->   ON DELETE RESTRICT ON UPDATE CASCADE;
Query OK, 0 rows affected (0.018 sec)
Records: 0 Duplicates: 0 Warnings: 0

MariaDB [Velocity_Motors]> DESC Branch;
+-----+-----+-----+-----+-----+-----+
| Field | Type      | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| BranchID | int(11)   | NO   | PRI | NULL    |       |
| BPhone   | varchar(10) | NO   |     | NULL    |       |
| City     | varchar(20) | NO   |     | NULL    |       |
| State    | varchar(20) | NO   |     | NULL    |       |
| Zip      | varchar(10) | YES  |     | NULL    |       |
| MID      | int(11)   | YES  | MUL | NULL    |       |
+-----+-----+-----+-----+-----+-----+
6 rows in set (0.009 sec)

```

```

MariaDB [Velocity_Motors]> ALTER TABLE Employee ADD CONSTRAINT FK_EmployeeBranch
-> FOREIGN KEY (BID) REFERENCES Branch(BranchID)
-> ON DELETE CASCADE ON UPDATE CASCADE;
Query OK, 0 rows affected (0.010 sec)
Records: 0 Duplicates: 0 Warnings: 0

MariaDB [Velocity_Motors]> DESC Employee;
+-----+-----+-----+-----+-----+-----+
| Field | Type          | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| EID   | int(11)       | NO   | PRI | NULL    |       |
| EName | varchar(100)  | NO   |     | NULL    |       |
| EPhone | varchar(10)   | NO   |     | NULL    |       |
| Email | varchar(100)  | NO   |     | NULL    |       |
| DoB   | date          | YES  |     | NULL    |       |
| BID   | int(11)       | YES  | MUL | NULL    |       |
+-----+-----+-----+-----+-----+-----+
3 rows in set (0.009 sec)

```

```

MariaDB [Velocity_Motors]> ALTER TABLE CarRegistration ADD CONSTRAINT FK_CarRegistrationCar
-> FOREIGN KEY (Lnumber) REFERENCES Car(LicenseNumber)
-> ON DELETE CASCADE ON UPDATE CASCADE;
Query OK, 0 rows affected (0.014 sec)
Records: 0 Duplicates: 0 Warnings: 0

MariaDB [Velocity_Motors]> DESC CarRegistration;
+-----+-----+-----+-----+-----+-----+
| Field | Type          | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| Lnumber | varchar(15) | NO   | PRI | NULL    |       |
| RegDate | date        | NO   |     | NULL    |       |
| RegExDate | date      | NO   |     | NULL    |       |
+-----+-----+-----+-----+-----+-----+
3 rows in set (0.010 sec)

```

```

MariaDB [Velocity_Motors]> ALTER TABLE Insurance ADD CONSTRAINT FK_InsuranceCar
-> FOREIGN KEY (Lnumber) REFERENCES Car(LicenseNumber)
-> ON DELETE CASCADE ON UPDATE CASCADE;
Query OK, 0 rows affected (0.017 sec)
Records: 0 Duplicates: 0 Warnings: 0

MariaDB [Velocity_Motors]> DESC Insurance;
+-----+-----+-----+-----+-----+-----+
| Field | Type          | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| InsuranceID | int(11) | NO   | PRI | NULL    |       |
| Type | varchar(50) | NO   |     | NULL    |       |
| InsDetails | varchar(100) | YES  |     | NULL    |       |
| Lnumber | varchar(15) | YES  | MUL | NULL    |       |
+-----+-----+-----+-----+-----+-----+
4 rows in set (0.008 sec)

```

```

MariaDB [Velocity_Motors]> ALTER TABLE Ownership ADD CONSTRAINT FK_OwnershipOwner
->
-> FOREIGN KEY (OID) REFERENCES Owner(OwnerID)
->
-> ON DELETE CASCADE ON UPDATE CASCADE;
Query OK, 0 rows affected (0.014 sec)
Records: 0 Duplicates: 0 Warnings: 0

MariaDB [Velocity_Motors]> DESC Ownership;
+-----+-----+-----+-----+-----+-----+
| Field | Type | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| OID   | int(11) | NO | PRI | NULL | |
| Lnumber | varchar(15) | NO | PRI | NULL | |
| PercentOwned | decimal(5,2) | NO | | NULL | |
+-----+-----+-----+-----+-----+-----+
3 rows in set (0.010 sec)

```

```

MariaDB [Velocity_Motors]> ALTER TABLE Ownership ADD CONSTRAINT FK_OwnershipCar
->
-> FOREIGN KEY (Lnumber) REFERENCES Car(LicenseNumber)
->
-> ON DELETE CASCADE ON UPDATE CASCADE;
Query OK, 0 rows affected (0.014 sec)
Records: 0 Duplicates: 0 Warnings: 0

MariaDB [Velocity_Motors]> DESC Ownership;
+-----+-----+-----+-----+-----+-----+
| Field | Type | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| OID   | int(11) | NO | PRI | NULL | |
| Lnumber | varchar(15) | NO | PRI | NULL | |
| PercentOwned | decimal(5,2) | NO | | NULL | |
+-----+-----+-----+-----+-----+-----+
3 rows in set (0.010 sec)

```

```

MariaDB [Velocity_Motors]> ALTER TABLE Associated ADD CONSTRAINT FK_AssociatedBranch
->
MariaDB [Velocity_Motors]> ALTER TABLE Associated ADD CONSTRAINT FK_AssociatedEmployee
->
-> FOREIGN KEY (EID) REFERENCES Employee(EID)
->
-> ON DELETE CASCADE ON UPDATE CASCADE;
Query OK, 0 rows affected (0.017 sec)
Records: 0 Duplicates: 0 Warnings: 0

MariaDB [Velocity_Motors]> DESC Associated;
+-----+-----+-----+-----+-----+-----+
| Field | Type | Null | Key | Default | Extra |
+-----+-----+-----+-----+-----+-----+
| BID   | int(11) | NO | MUL | NULL | |
| EID   | int(11) | NO | MUL | NULL | |
| Lnumber | varchar(15) | NO | PRI | NULL | |
+-----+-----+-----+-----+-----+-----+
3 rows in set (0.011 sec)

```

```

MariaDB [Velocity_Motors]> ALTER TABLE Associated ADD CONSTRAINT FK_AssociatedCar
-> FOREIGN KEY (Lnumber) REFERENCES Car(LicenseNumber)
-> ON DELETE CASCADE ON UPDATE CASCADE;
Query OK, 0 rows affected (0.015 sec)
Records: 0 Duplicates: 0 Warnings: 0

```

```

MariaDB [Velocity_Motors]> DESC Associated;

```

Field	Type	Null	Key	Default	Extra
BID	int(11)	NO	MUL	NULL	
EID	int(11)	NO	MUL	NULL	
Lnumber	varchar(15)	NO	PRI	NULL	

```

3 rows in set (0.009 sec)

```

```

MariaDB [Velocity_Motors]>

```

```

MariaDB [Velocity_Motors]> ALTER TABLE CarRegistration ADD CONSTRAINT CHK_RegDate
-> CHECK (RegDate < RegExDate);
Query OK, 0 rows affected (0.055 sec)
Records: 0 Duplicates: 0 Warnings: 0

```

```

MariaDB [Velocity_Motors]> DESC CarRegistration;

```

Field	Type	Null	Key	Default	Extra
Lnumber	varchar(15)	NO	PRI	NULL	
RegDate	date	NO		NULL	
RegExDate	date	NO		NULL	

```

3 rows in set (0.029 sec)

```

```

MariaDB [Velocity_Motors]> _

```