Technical University of Denmark

DTU Compute
Department of Applied Mathematics and Computer Science

# Mandatory Group Project 2018

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# Contents

- Practical information (on groups, hand-in and evaluation).
- The project tasks and requirements.

# Practical Information

- Mandatory
  - It is mandatory to hand in a mandatory group project and get it approved in order to participate in the final written examination!
  - The final mark for this course is the mark from the written examination.

- Groups
  - Project groups must consist **of 3-4 participants**!
  - **Group must have been registered** during the exercises on the **8. and 15. March**!
  - Unregistered students have been allocated a project group by me!
  - The groups and their numbers can be found in a file in the Project folder in the course File Sharing on DTU Inside.

- Hand-In: What, Where and When
  - Upload the following files to the Course Assignments folder on DTU Inside, not later than **Wednesday April 18th**:
    1. The group project report in a .pdf file. It must have the sections explained on later pages.
    2. A MySQL script file in a .sql file containing
       (1) the statements used to create the database, its tables and views (in section 5 of the report)
       (2) the statements used to populate the tables (in section 6)
       (3) the queries made (in section 7)
       (4) the insert/delete/update statements used to change the tables (in section 8), and
       (5) the statements used to create and apply functions, procedures, triggers, and events (in section 9)

       It is a requirement that there are no errors when running the script.
- The Results of the Group Project Evaluation
  - Will be communicated via DTU Inside.

# Task, Objectives, and Scope

- Task:
  - is to develop and document a database system of your own choice.
- Objective:
  - is to get practical experience with data modelling and database design.
- Scope:
  - Only SQL programming of the database is requested, no application logic and no user interface. MySQL must be used for the implementation.

# Examples of Database Systems

- For inspiration, examples of systems developed by past 02170 students:
  - Boy Scout Administration System
  - Hospital Doctor & Patient Relations Administration
  - Blood Bank Operation System
  - Pigs Transport System
  - Personal Movie Rating System
  - Software Development Management System
  - Airport Control Database
  - Grandma's Bakery
  - Hero Corporation Skills Management
  - Web Banking System
  - Retail Shop Database
  - SuperMarket Inventory System
  - Superliga - Soccer Matches & Results Database
  - Project Management System
  - Laundry Card Administration System

# Mandatory Report Requirements

| Mandatory Sections | Tasks and Contents of Mandatory Sections |
|---|---|
| Title Page | Course Name & No, Group No, Project Title, Student Names and IDs, Date. |
| 1. Statement of Requirements | Describe in plain words the part of the real world being modelled. |
| 2. Conceptual Design | Show an Entity-Relationship Diagram for the domain of your database using the Textbook Adapted UML Notation. Explain. Discuss choices made. |
| 3. Logical Design | Convert your conceptual design into a logical design (relation schemas) and discuss any choices made. Show a database schema diagram in the Textbook notation. |
| 4. Normalization | For each relation schema in your logical design, state its normal form and explain why it is in the given normal form. Ensure that all become in at least 3NF. |
| 5. Implementation | Create a MySQL database with tables and views implementing the logical design. |
| 6. Database Instance | Populate the tables with data and list data for all tables and views. |
| 7. SQL Data Queries | Give examples of typical select SQL statements with order by, group by and joins etc. For each query explain informally what it asks about. |
| 8. SQL Table Modifications | Give examples of typical SQL table insert, update and delete statements. |
| 9. SQL Programming | Give examples of functions, procedures, transactions, triggers, and events, and explain what they do. Give at least one example of each. |

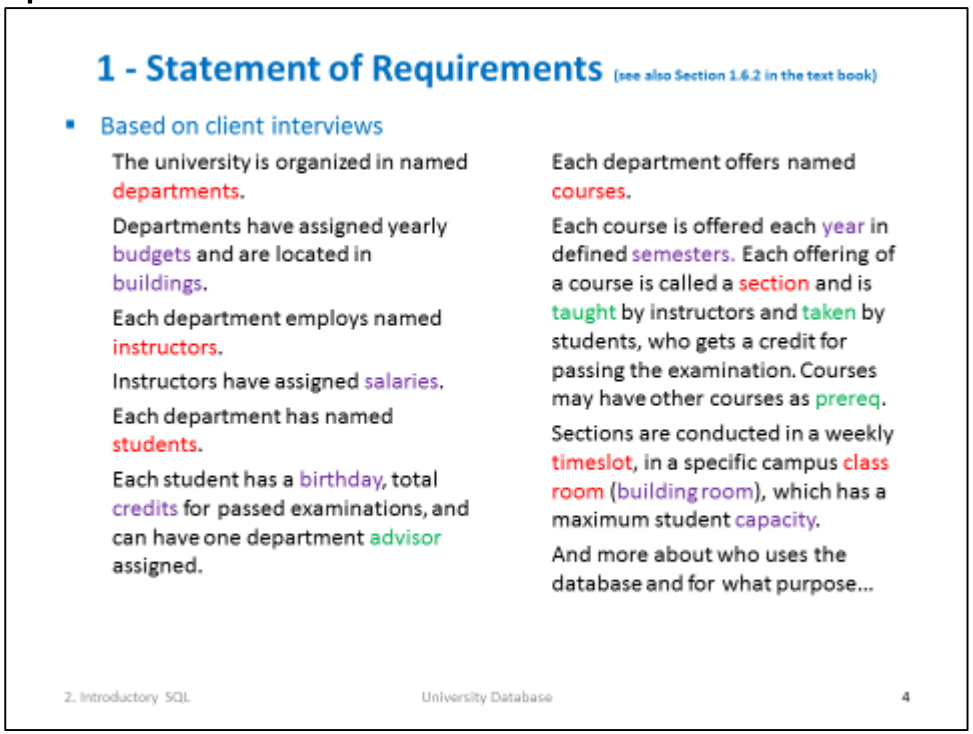
# Title Page and Report Format

- Title Page
  - Make the Title Page inviting and interesting
    - It gives the reader a first good impression
  - Include
    - Course name & number
    - Project title
    - Group number (as found in the Project folder of the file sharing on DTU Inside)
    - Student names, IDs, and pictures (the last is optional)
    - Date

- Report Format
  - Include page numbers.
  - Include a table of contents.
  - Include pictures and drawings to clarify text.
  - Use readable fonts for various text elements and picture captions.
  - Include an appendix for additional material, if needed.
  - Include a bibliography, if needed.

# 1. Statement of Requirements

- Describe in plain words the part of the real world being modelled.
  - Example from a slide :



**1 - Statement of Requirements** (see also Section 1.6.2 in the text book)

- Based on client interviews

The university is organized in named departments.

Departments have assigned yearly budgets and are located in buildings.

Each department employs named instructors.

Instructors have assigned salaries.

Each department has named students.

Each student has a birthday, total credits for passed examinations, and can have one department advisor assigned.

Each department offers named courses.

Each course is offered each year in defined semesters. Each offering of a course is called a section and is taught by instructors and taken by students, who gets a credit for passing the examination. Courses may have other courses as prereq.

Sections are conducted in a weekly timeslot, in a specific campus class room (building room), which has a maximum student capacity.

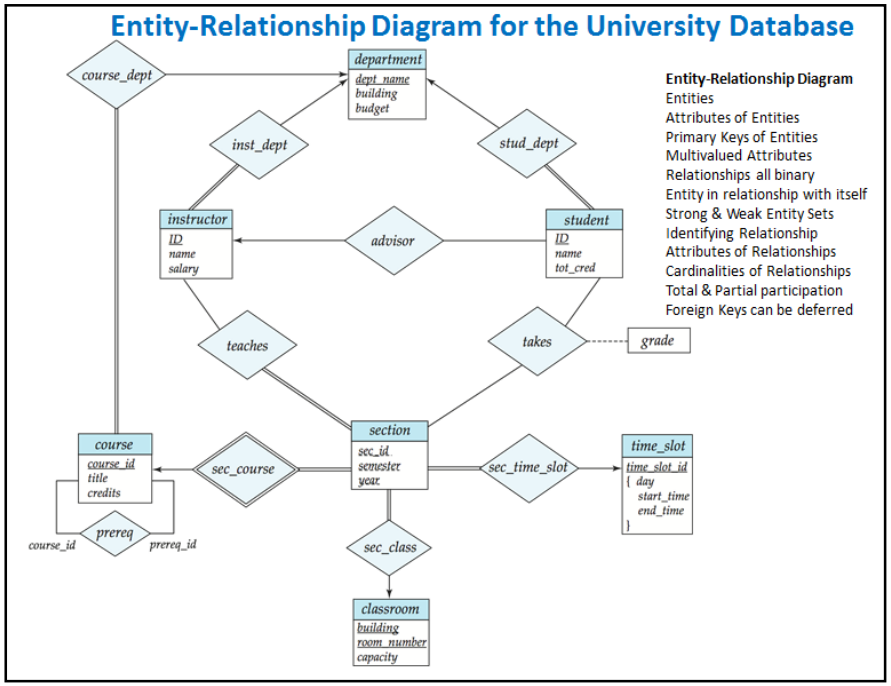
And more about who uses the database and for what purpose...

2. Introductory SQL University Database 4

However, make the text in readable and complete paragraphs and sentences!

# 2. Conceptual Design

- Show an Entity-Relationship Diagram for the domain of your database using the Textbook Adapted UML Notation.
  - Use the Textbook Adapted UML Notation and follow the strict rules to show (1) strong & weak entity sets with their names, attributes and primary keys, and (2) relationship sets with their names, attributes, primary keys, cardinalities, and total/partial participation.
  - Example:



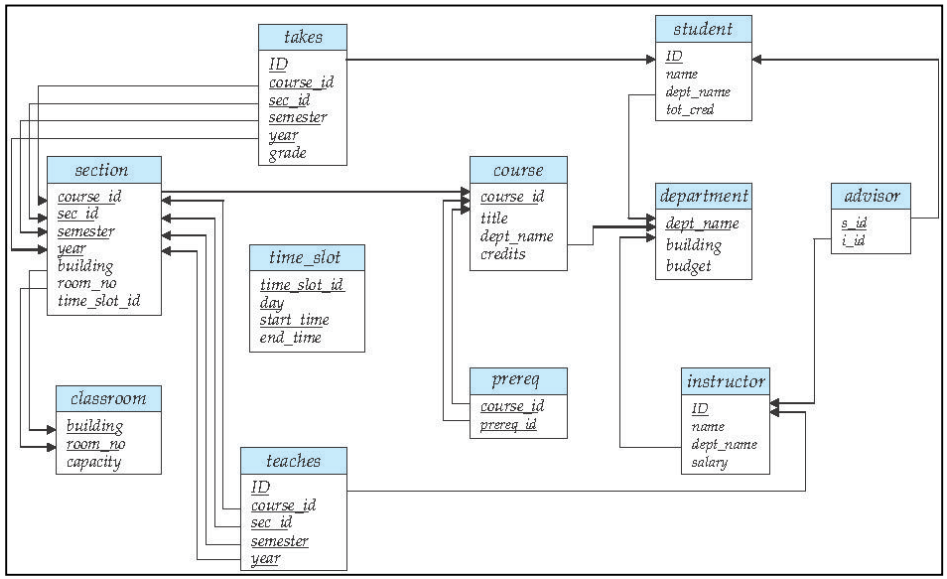

- Explain. Explain the meaning of entities, relationships, and their attributes.
- Discuss any choices made. E.g. why the cardinalities and participation constraints are chosen as they are etc.

# 3. Logical Design

- Convert your conceptual design into a logical design (relation schemas inclusive specification of foreign keys) and discuss any choices made. You must follow the method described in the book (Chapter 7).
  - Example: Conversion of the diagram shown on previous slides gives

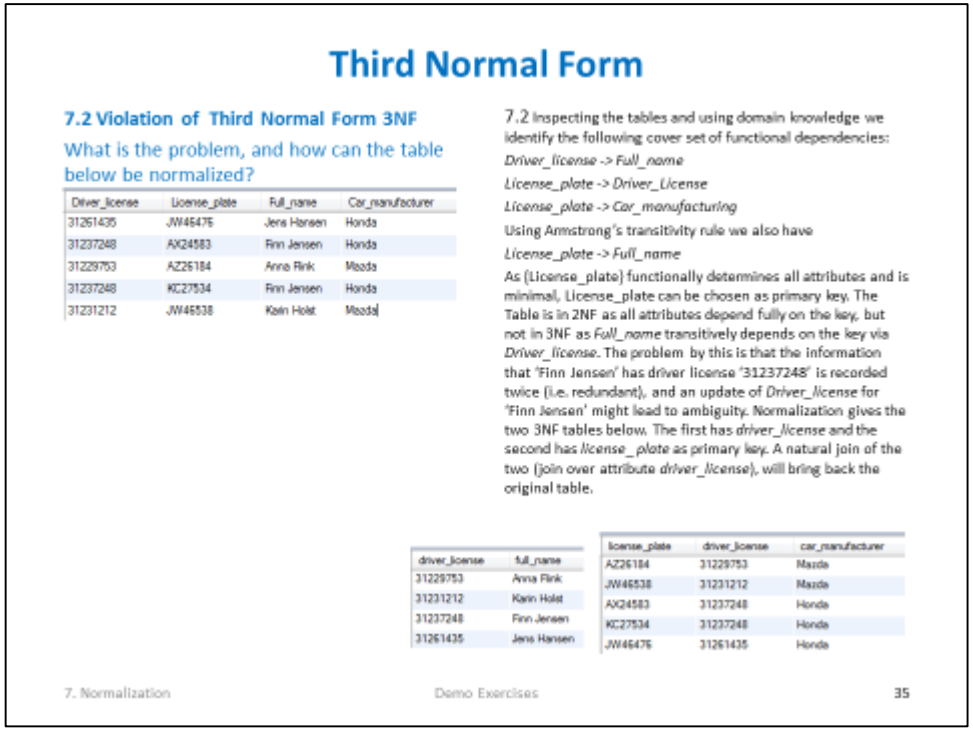
    Instructor(<u>InstID</u>, InstName, DeptName, Salary) **foreign key** (DeptName) **references** Department(DeptName)
    Department(<u>DeptName</u>, Building, Budget)
    ….
- Show a database schema diagram for the relation schemas of the logical design in the Textbook notation. Example of a database schema diagram for the University DB:

Textbook notation:



# 4. Normalization

- For each relation schema in your logical design, state its normal form and explain why it is in the given normal form.
- Ensure that all become in at least 3NF. If some tables are not in 3NF: Then check whether this is due to some problems in your conceptual model or its conversion to a logical design. If so fix the problems, otherwise normalize the tables directly to 3NF.
  - Example:



## Third Normal Form

**7.2 Violation of Third Normal Form 3NF**

What is the problem, and how can the table below be normalized?

| Driver_license | License_plate | Full_name | Car_manufacturer |
|---|---|---|---|
| 31261435 | JW46476 | Jens Hansen | Honda |
| 31237248 | AX24583 | Finn Jensen | Honda |
| 31229753 | AZ26184 | Anna Fink | Mazda |
| 31237248 | KC27534 | Finn Jensen | Honda |
| 31231212 | JW46538 | Karin Holst | Mazda |

7.2 Inspecting the tables and using domain knowledge we identify the following cover set of functional dependencies:

*Driver_license -> Full_name*

*License_plate -> Driver_License*

*License_plate -> Car_manufacturing*

Using Armstrong's transitivity rule we also have

*License_plate -> Full_name*

As {License_plate} functionally determines all attributes and is minimal, License_plate can be chosen as primary key. The Table is in 2NF as all attributes depend fully on the key, but not in 3NF as *Full_name* transitively depends on the key via *Driver_license*. The problem by this is that the information that 'Finn Jensen' has driver license '31237248' is recorded twice (i.e. redundant), and an update of *Driver_license* for 'Finn Jensen' might lead to ambiguity. Normalization gives the two 3NF tables below. The first has *driver_license* and the second has *license_plate* as primary key. A natural join of the two (join over attribute *driver_license*), will bring back the original table.

| driver_license | full_name |
|---|---|
| 31229753 | Anna Fink |
| 31231212 | Karin Holst |
| 31237248 | Finn Jensen |
| 31261435 | Jens Hansen |

| license_plate | driver_license | car_manufacturer |
|---|---|---|
| AZ26184 | 31229753 | Mazda |
| JW46538 | 31231212 | Mazda |
| AX24583 | 31237248 | Honda |
| KC27534 | 31237248 | Honda |
| JW46476 | 31261435 | Honda |

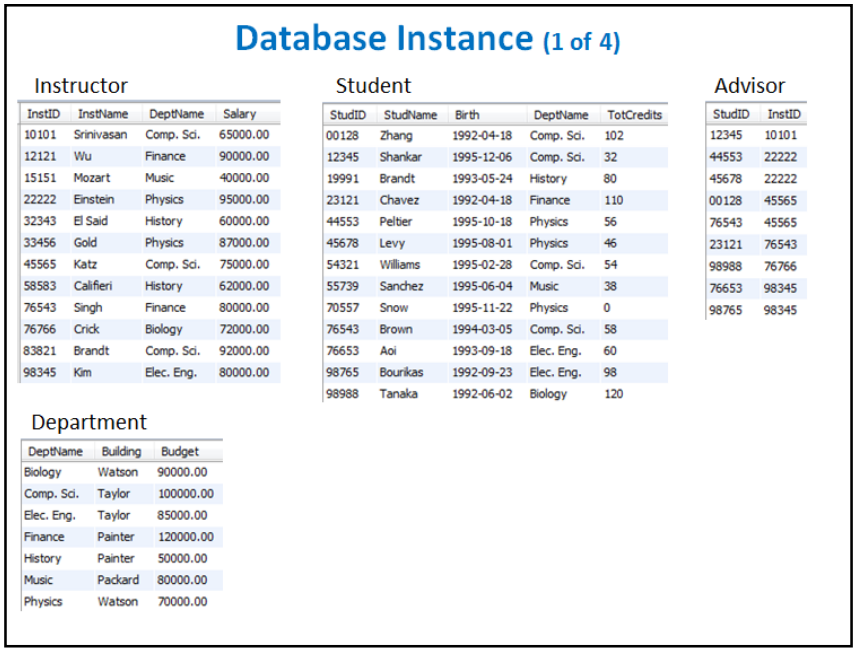
7. Normalization Demo Exercises 35

# 5. Implementation

- Create a MySQL database with tables and views implementing the logical design (as achieved after possible revisions in step 4):
  - Use MySQL statements CREATE DATABASE, CREATE TABLE and CREATE VIEW.

# 6. Database Instance

- Populate the tables with data and list data for all tables and views.
  1. Use MySQL **INSERT** to populate the tables.
  2. Use MySQL **SELECT * FROM** *table* to list instances of all tables and views.
  3. Show the result of step 2 in the report.
- Example from one of the course slides



**Database Instance (1 of 4)**

Instructor

| InstID | InstName | DeptName | Salary |
|---|---|---|---|
| 10101 | Srinivasan | Comp. Sci. | 65000.00 |
| 12121 | Wu | Finance | 90000.00 |
| 15151 | Mozart | Music | 40000.00 |
| 22222 | Einstein | Physics | 95000.00 |
| 32343 | El Said | History | 60000.00 |
| 33456 | Gold | Physics | 87000.00 |
| 45565 | Katz | Comp. Sci. | 75000.00 |
| 58583 | Califieri | History | 62000.00 |
| 76543 | Singh | Finance | 80000.00 |
| 76766 | Crick | Biology | 72000.00 |
| 83821 | Brandt | Comp. Sci. | 92000.00 |
| 98345 | Kim | Elec. Eng. | 80000.00 |

Student

| StudID | StudName | Birth | DeptName | TotCredits |
|---|---|---|---|---|
| 00128 | Zhang | 1992-04-18 | Comp. Sci. | 102 |
| 12345 | Shankar | 1995-12-06 | Comp. Sci. | 32 |
| 19991 | Brandt | 1993-05-24 | History | 80 |
| 23121 | Chavez | 1992-04-18 | Finance | 110 |
| 44553 | Peltier | 1995-10-18 | Physics | 56 |
| 45678 | Levy | 1995-08-01 | Physics | 46 |
| 54321 | Williams | 1995-02-28 | Comp. Sci. | 54 |
| 55739 | Sanchez | 1995-06-04 | Music | 38 |
| 70557 | Snow | 1995-11-22 | Physics | 0 |
| 76543 | Brown | 1994-03-05 | Comp. Sci. | 58 |
| 76653 | Aoi | 1993-09-18 | Elec. Eng. | 60 |
| 98765 | Bourikas | 1992-09-23 | Elec. Eng. | 98 |
| 98988 | Tanaka | 1992-06-02 | Biology | 120 |

Advisor

| StudID | InstID |
|---|---|
| 12345 | 10101 |
| 44553 | 22222 |
| 45678 | 22222 |
| 00128 | 45565 |
| 76543 | 45565 |
| 23121 | 76543 |
| 98988 | 76766 |
| 76653 | 98345 |
| 98765 | 98345 |

Department

| DeptName | Building | Budget |
|---|---|---|
| Biology | Watson | 90000.00 |
| Comp. Sci. | Taylor | 100000.00 |
| Elec. Eng. | Taylor | 85000.00 |
| Finance | Painter | 120000.00 |
| History | Painter | 50000.00 |
| Music | Packard | 80000.00 |
| Physics | Watson | 70000.00 |

# 7. SQL Data Queries

- Give examples of typical select SQL statements with order by, group by and joins etc. For each query explain informally what it asks about.
  - Example illustrating group by:

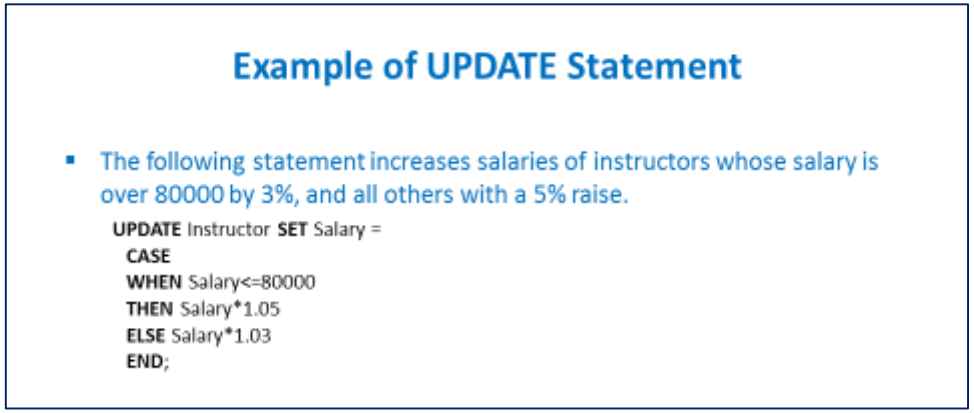
- Find the name and average salary for those departments whose average salary is greater than 42000.

```
SELECT DeptName, AVG(Salary) FROM Instructor
GROUP BY DeptName HAVING AVG(Salary) > 65000;
```

| DeptName | AVG(Salary) |
|---|---|
| Biology | 72000.000000 |
| Comp. Sci. | 77333.333333 |
| Elec. Eng. | 80000.000000 |
| Finance | 85000.000000 |
| Physics | 91000.000000 |

# 8. SQL Table Modifications

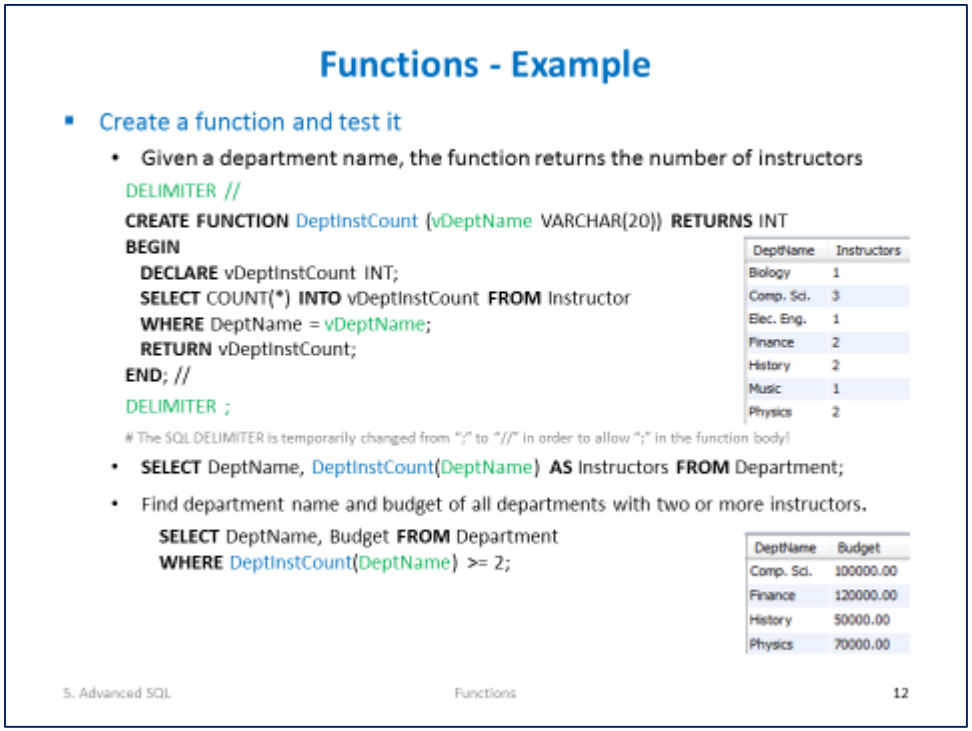
- Give examples of typical SQL table insert, update and delete statements.
  - Show with illustrative examples how you do table modifications using the SQL commands INSERT, UPDATE and DELETE.
- Example:




Also show the contents of the table after the insert/update/delete.

# 9. SQL Programming

- Give examples of functions, procedures, transactions, triggers, and events, and explain what they do. Give at least one example of each.
  - Remember also to give illustrative examples of how they work.
- Example:



## Functions - Example

- Create a function and test it
  - Given a department name, the function returns the number of instructors

```
DELIMITER //
CREATE FUNCTION DeptInstCount (vDeptName VARCHAR(20)) RETURNS INT
BEGIN
  DECLARE vDeptInstCount INT;
  SELECT COUNT(*) INTO vDeptInstCount FROM Instructor
  WHERE DeptName = vDeptName;
  RETURN vDeptInstCount;
END; //
DELIMITER ;
```

| DeptName | Instructors |
|---|---|
| Biology | 1 |
| Comp. Sci. | 3 |
| Elec. Eng. | 1 |
| Finance | 2 |
| History | 2 |
| Music | 1 |
| Physics | 2 |

# The SQL DELIMITER is temporarily changed from ";" to "//" in order to allow ";" in the function body!

  - `SELECT DeptName, DeptInstCount(DeptName) AS Instructors FROM Department;`
  - Find department name and budget of all departments with two or more instructors.

```
SELECT DeptName, Budget FROM Department
WHERE DeptInstCount(DeptName) >= 2;
```

| DeptName | Budget |
|---|---|
| Comp. Sci. | 100000.00 |
| Finance | 120000.00 |
| History | 50000.00 |
| Physics | 70000.00 |

5. Advanced SQL Functions 12