



LABORATORY MANUAL

CZ2007: Introduction to Databases

Software Lab 2 (Location: N4-01c-06)

or

Software Lab 3 (Location: N4-B1c-14)

Implementation of a Database Application

**SCHOOL OF COMPUTER SCIENCE AND
ENGINEERING
NANYANG TECHNOLOGICAL UNIVERSITY**

1. **OBJECTIVES**

Upon completion of the assignment, the student should be able to:

- a. Construct an entity-relationship model at a conceptual level
- b. Map the model into a schema of a relational DBMS
- c. Implement the given schema on a relational DBMS
- d. Use a database language (SQL) for manipulating and updating data

2. **LABORATORY**

This is a group assignment. Each group is expected to consist of **4** members from your laboratory group and will be assigned by your Lab tutor randomly during your first laboratory session.

Note that the laboratory will start from the **third week** of the semester onwards and that you might need more than the mentioned five sessions for the actual implementation. You are also encouraged to **start early** with your assignment (as soon as the topic is covered in the lectures).

Attendance is taken for all supervised laboratory sessions. It is the responsibility of each student to sign-in at the beginning of each session. **Failing to sign-in for the first, third, or fifth lab session without MC will result in a 10 mark reduction (out of 100) for the respective assessment.**

For each lab submission, each group need to specify individual contributions, and the percentage of contribution of each member among all group members. If the difference of contributions for a submission is large, the final mark of each group member may be adjusted based on the group score and individual contributions for the submission. If the group members make similar contribution or the difference is small, all group members will get the same mark, i.e., the group score. The policy is to encourage every group member contribute to the Lab and learn from the Lab. **Only group score is released**

The contribution form is given in Appendix C

3. **INTRODUCTION**

The assignment covers the portion of the course concerning data modelling, database design and implementation from the user's viewpoint. Thus, the assignment involves modelling as well as implementation aspects of the database course.

The overall aim of the laboratory is to develop an application based on a given data model using a given database management system. This exercise will bring you through a crucial first part of the life cycle of a database application. It is assumed that the data analysis has been performed. Note that this manual provides you with more information than is required for the first laboratory session; e.g., not all constraints can be modelled in the beginning but are included at a later implementation stage. In contrast you might require additional information for the understanding of the application. Proceed by stating your assumptions in written form and / or ask your laboratory supervisor.

4. **DESCRIPTION OF THE ASSIGNMENT**

The description of the application is given in the appendices. This includes the back-ground and general requirements of the application, conceptual information about the system and its users as well as a list of queries that must be fulfilled as a minimum.

Note that teamwork is required. Every team has to submit one solution. **No individual submission will be accepted.**

4.1 **First Laboratory Session: Creating an ER Diagram**

Appendix A gives conceptual information about the project obtained after a partial system analysis was performed. Based on the appendices, construct a suitable ER diagram. Analyse the cardinality of relationships, the usage of weak entity sets, choice of entity sets etc. and compare them with alternative solutions. The laboratory technicians will provide the necessary information at the beginning of the lab session.

You need to submit the followings at latest **three working days** after the first laboratory session.

- A hard copy of your ER diagram and written discussion of your solution (maximum one page), which highlights the reasons for the chosen design.

4.2 **Second Laboratory Session: Finalization of the ER Diagram**

There is no submission for the second laboratory session. In this lab, each group should finalize their database design based on the feedback received from their lab supervisor. Please note that the second laboratory session is a free-access session; i.e., attendance is not compulsory (but recommended in case the group has questions).

4.3 **Third Laboratory Session: Generation of Normalized Database Schema**

In this lab you must ensure that the database is at least in 3NF. Follow the general guide-lines covered during the lectures and tutorials to produce suitable normalized relations. For each relation, the key(s), primary key, and functional dependencies must be specified. If a relation is generated due to normalization of an original relation, then the normalization steps must be presented.

You need to submit the followings at latest **three working days** after the third laboratory session.

- A hardcopy of the normalized database schema and FDs associated with each relation. If a relation created from the ER diagram violates the 3NF form then this should be highlighted along with the decomposed normalized relations. Note that for this lab no SQL code should be submitted. Hence, the structure of your solution shall be similar to the following example:

R1(A, B, C, D)

Keys: AB, AD

Primary Key: AB

FDs: $AB \rightarrow CD$, $A \rightarrow D$

The relation is in 3NF.

4.4 **Fourth Laboratory Session: Implementation of the database schema**

There is no submission for the third laboratory session. In this lab, the finalized database schema must be implemented using SQL DDL commands. Your implementation should clearly incorporate the primary and foreign keys, data types, integrity constraints, value-based and tuple-based constraints. Solve the implementation by using the MS SQL Server software.

Please note that the fourth laboratory session is a free-access session, i.e., attendance is not compulsory (but recommended in case the group has questions).

4.5 **Fifth Laboratory Session: Final demonstration**

The fifth session is the final assessment of your implementation. The implementation obtained from the previous laboratory session has to be extended by incorporating necessary constraints. In addition, you have to formulate the SQL statements for the sample queries in Appendix B.

This session has two components. First, **at the beginning of the lab** a hardcopy of the schema implemented using the SQL DDL commands together with constraints and sample queries need to be submitted. Auto-generated relations are not permitted. Hence, the structure of your solution for the database schema definition shall be similar to the following example and written by yourselves:

```
CREATE TABLE name (  
    attr1 datatype NOT NULL,  
    attr2 datatype,  
    ...  
    PRIMARY KEY (attr1),  
    FOREIGN KEY (attr3) REFERENCES name(attr1)  
        ON DELETE ... ON UPDATE ...,  
);
```

The second component of this session involves **demonstration** of your system. All team members are required to contribute actively during the demonstration session. Additionally, the laboratory supervisor will ask individual questions. During the demo session, the evaluation shall be based on the following points:

- Implementation and execution of additional queries on the spot
- Answers on and understanding of the design and related issues
- Demonstration of the proper working of your implementation
- Additional effort in terms of implementation etc.
- Presentation quality

Note that your group might be required to begin the presentation at any time during the fifth laboratory session; i.e., one team will be asked to present at the beginning of the session. All applications should run on the provided hardware and software components of the Software Laboratory 2 using MS SQL Server.

Note that Lab 1 and Lab 5 will contribute larger portions for the final score as they need more efforts than Lab 3 in general.

APPENDIX A

User requirements about the DBMS

You are to design a database system for Advanced Contract Tracing. The basic features of the system are as follows:

- Each person/user is identified by an ID (NRIC or Passport number) and has a unique email address. Basic info of the user, including name, sex, birthday (year, month and date), phone number, company, and hometown are stored.
- Each company has an ID, contact email, mailing address, and contact person.
- The system records the family member information of every user, i.e., the partner and children who live together.
- Every 12 hours, the system will prompt each user to declare temperature, and the temperature will be recorded.
- Each location (e.g., a shop or a building) is identified by an id, and has unique coordinates. Basic info of a location includes name, address, description, company of the location. Each location may also be associated with several category labels (e.g., coffee shop). We have a hierarchy of categories, (e.g., under category Education, we have subcategory University).
- The system will record the coordinates of a user every 5 minutes automatically (e.g., by a GPS device) in the database. If the system finds that a user visits a new location (e.g., if movement in a circle region of 50 meters in the last 15 minutes in a new region), the system will record the check-in information, such as the check-in time, the check-in location in the database. Note that you do not need to implement how the system detects a check-in.
- When the system detects that a user leaves a location, it prompts the user to check out the current location. The check-out time should be recorded.
- The system maintains an online forum, in which the system administrator may post a message on any location. The contact person of a company may post a message on any location that belongs to the company (but not locations that do not belong to the company). Any user may comment on an existing post.
- The system maintains a rating system. Each user may choose rate the location that the user checked in when the user checks out. The rating is between 1 to 5, and is on how well the location is coping with the pandemic. A user can also leave a review or comment at check-in.
- The system will automatically schedule swap test slot for people who are in high risks, and the schedule is stored in the database. Each schedule records time, person, clinic location, and the test result.

Note that Appendix A only gives the scope of the project, and understanding and defining user requirement is a necessary part of database design in practice. The provided information is not complete. Many aspects of the system's functions and details have been omitted. It is expected that the teams come up with their own solutions in case of inconsistencies or missing information. However, you have to keep track of these aspects and explain your assumptions if asked for the reasons. Extensions to the implementation of the basis system are encouraged. Focus on database design and implementation though, and no graphical/web user interface is required.

APPENDIX B

Queries

- Find the locations that receive at least 5 ratings of "5" in Dec 2020, and order them by their average ratings.
- Find the companies whose posts have received the most number of comments for each week of the past month.
- Find the users who have checked in more than 10 locations every day in the last week.
- Find all the couples such that each couple has checked in at least 2 common locations on 1 Jan 2021.
- Find 5 locations ids and their names that are checked in by the most number of users in the last 10 days.
- Given a user, find the list of uses that checked in the same locations with the user within 1 hour in the last week.

Design **two queries** that are not in the above list. They are evaluated based on the usefulness, complexity, and the interestingness. You are encouraged (not compulsory) to design trigger queries, from which you can learn something different and new.

APPENDIX C

For each submitted lab report, you need to include the following **Individual Contribution Form** as part of your submission. The form would be took into consideration in marking.

Name and signature	Individual Contributions (to justify the percentage contribution)	Percentage of Contribution (100% in total)