LABORATORY MANUAL

CZ2007: Introduction to Databases
Software Lab 2 (Location: N4-01c-06)

Implementation of a Database Application

2017/2018 SEMESTER 1

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
NANYANG TECHNOLOGICAL UNIVERSITY

1. OBJECTIVES

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

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

2. LABORATORY

This is a group assignment. Each group consists of **four to five** members from your laboratory group. You have the choice of selecting your group members. However, all the names within your group must be given to the laboratory technician(s) during your first laboratory session. Name lists with respect to each laboratory group are available in the "Public Folders" towards the beginning of the semester.

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 within 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 may result in F grade for the respective assessment.**

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 background 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 is allowed.**

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 due with respect to 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 guidelines 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` → `CD`, `A` → `D`
  The relation is in 3NF.

4.4 Fourth Laboratory Session: Implementation of the database schema

There is no submission due with respect to 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 triggers and additional 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.

APPENDIX A

Suppose that you are to construct a database for the Gotham Hospital, and the requirements are as follows:

- There are four groups of people on whom the hospital is most dependent: employees, physicians, patients and volunteers. Some common attributes are shared by all of these persons: Person_ID (identifier), Name, Address, City/State/Zip, Birth_Date, and Phone. Each of the four groups has at least one unique attribute of its own. Employees have a Date_Hired; volunteers have a Skill; Physicians have a Specialty and Phone_Number; patients have a Contact_Date. There are also additional personnel in the hospital community that do not belong to one of these four groups (their numbers are relatively small). However, a particular person may belong to two (or more) of these groups at any given time (e.g., a person can belong to both Patient and Volunteer).

- Each patient has one (and only one) physician responsible for that patient. A given physician may not be responsible for a patient at a given time or may be responsible for one or more patients. Patients are divided into two groups: resident and outpatient. Each resident has a Date_Admitted attribute. Each outpatient is scheduled for zero or more visits. The entity visit has two attributes: Date (partial identifier) and Comments. Notice that an instance of visit cannot exist without an outpatient owner entity.

- Employees are subdivided into three groups: nurse, staff, and technician. Only nurses have the attribute Certificate, which indicates the qualification. Only staff has the attribute Job_Class, and only technicians have the attribute skill. Each nurse is assigned to one (and only one) care centre. Examples of care centres are Maternity, Emergency, and Cardiology. Attributes of the care centre are Name (identifier) and Location. A care centre may have one or more nurses assigned to it. Also for each care centre, one of the nurses assigned to that care centre is appointed nurse_in_charge. A nurse cannot be appointed nurse_in_charge of a care centre unless she or he has a Registered Nurse (RN) certificate.

- Each technician is assigned to one or more laboratories. Attributes of a laboratory include Name (identifier) and Location. A laboratory must have at least one technician assigned to it and may have any number of technicians assigned.

- There may be no beds assigned to a care centre, or a care centre may have one or more beds (up to any number) assigned to it. There are two attributes of a bed, namely, Bed_Number and Room_Number, which jointly identifies a bed. Each resident patient must be assigned to a bed. A bed may or may not have a resident patient assigned to it at a given time.

Note that the provided information may not be complete. Many aspects of the system's functions and details may 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 basic system are encouraged.

APPENDIX B

Queries

1. Find all Volunteers who do not have any skills.
2. Find each Physician who visited an Outpatient for whom he or she was not responsible for.
3. Find each Outpatient who has been visited exactly once.
4. For each Skill, list the total number of volunteers and technicians that achieve this skill.
5. Find all Patients who have been admitted within one week of their Contact Date.
6. List all Physicians who have made more than 3 visits on a single day.