NANYANG TECHNOLOGICAL UNIVERSITY
SINGAPORE

LABORATORY MANUAL

CZ2007: Introduction to Databases

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 **four** members from your laboratory group and will be decided during your first laboratory session. You may try to form your own group.

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 10 marks reduction (out of 100) for the respective assessment.**

In the submission of Lab 5, each group need to specify individual contributions to each lab submission (3 submissions in total), 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.

The contribution form is given in Appendix D.

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 sys-tem analysis was performed. Based on the appendices, construct a suitable ER diagram. Analyze 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 → CD, A → 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.

APPENDIX A

User requirements about the DBMS

- Each customer of the platform is identified by an id and has a unique username and a unique email address. Other information about the customer, including password, full name, address, and phone number, is also maintained.

- A customer may have one or more credit cards registered with the website. The credit card number and other related information of the credit card are kept.

- The platform may host many shops. Each shop has a name and a unique shop id. Each shop sells different projects. Every product has a name, color, size, price and description. It may also have one or several photos. A product belongs to a certain product type identified by a product type id. A product type has a description and all product types form a hierarchy - a product type may have one other product type as its parent. Some shops are restricted to sell a subset of types of products only.

- A customer can place an order. Each order is identified by an order id and the date of the order as well as a status ('processing', 'completed' or 'cancelled') is maintained.

- An order may contain one or more order items (products). For each order item (product), we keep the product unit price, the quantity of the product ordered as well as a status ('processing', 'shipped' or 'out of stock'), and some other related information. Each order item may have a sequence number, which is unique within each order. Note that the order price can be different from the product price.

- An invoice is issued for every order. Each invoice carries an invoice number, a date and a status ('issued' or 'paid').

- Payment can be made for an invoice. The payment id, date and the amount are captured. Partial payment to an invoice can be made.

- Shipment will be made for items in a fully paid order. Items in an order may be shipped separately. The shipment id, items, date, and tracking number are recorded for each shipment.

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

- Given a customer by an email address, returns the product ids that have been ordered and paid by this customer but not yet shipped.
- Find the 3 bestselling product type ids in terms of product quantity sold. The products of concerned must be ordered and paid. Whether they have been shipped is irrelevant.
- Return the descriptions of all the 2nd level product types. The product types with no parent will be regarded as 1st level product types and their direct child product types will be regarded as 2nd level.
- Find 2 product ids that are ordered together the most.
- Get 3 random customers and return their email addresses.

Design two queries that are not in the above list. They are evaluated based on the usefulness, complexity, and the interestingness.

Appendix C
Constraints

- When the full payment to an invoice is made, the invoice status is changed from 'issued' to 'paid'.
- When an order item is shipped, its status is changed from 'processing' to 'shipped'.
- When all the products in an order have been shipped, the order status is changed from 'processing' to 'completed'.
- There can be at most 3 payments to an invoice, i.e., if the customer chooses to perform partial payments, the 3rd payment must complete the full amount.
- If an ordered has been paid, either fully or partially, it can no longer be cancelled, i.e., its status cannot be changed to 'cancelled'.

Appendix D

Individual Contribution Form

Name	Individual Contribution for Submission 1 (Lab 1)	Percentage of Contribution (100% in total)

Name	Individual Contribution for Submission 2 (Lab 3)	Percentage of Contribution (100% in total)

Name	Individual Contribution for Submission 3 (Lab 5)	Percentage of Contribution (100% in total)

<u>Name and Signature from all group members</u>

Name and Signature of Member 1

Name and Signature of Member 2

Name and Signature of Member 3

Name and Signature of Member 4

Name and Signature of Member 5