



LABORATORY MANUAL

SC2207/CZ2007: Introduction to Databases

Implementation of a Database Application

COLLEGE OF COMPUTING & DATA SCIENCE

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) to retrieval data from a relational DBMS.

2. INSTRUCTIONS

- a) **Team Formation**: This is a team-based assignment. Each team consists of **five to seven** members from your laboratory group, to be approved by your lab supervisor, to be formed during the Lab 1 session. The lab supervisor may add or remove members from your teams to ensure an even spread and mix of students in each team. The final members of your team must be submitted to the lab executive during the **Lab 1 session**.
- b) **Lab Submission**: There are five scheduled lab sessions for this team assignment. Laboratory sessions will start from the **Week 3** for those scheduled on odd weeks, or **Week 4** for those scheduled on even weeks. For Lab 1, 3 or 5 submissions, do include a **cover page** indicating the team number and team members. Names of team members must appear as they do in student cards; do not shorten or use nicknames or aliases.
- c) **Lab Attendance**: Attendance is taken for the **first, third and fifth** lab sessions only. Attendance for the second and fourth lab sessions is not mandatory.
- d) **Fair Participation**: Each student is expected to make fair and equal contribution to EACH lab, and thoroughly understand the expectations of EACH lab. E.g., it is NOT acceptable that a student contributes less to Lab 1 and make up for it by contributing more to Lab 5. Each submission needs to indicate contributions from each member. The final marks of a team member may be adjusted based on the team score and individual contribution. **Appendix C is to be submitted with each submission.**
- e) **Lab Supervisors**: For each lab session, there is a lab supervisor and a lab executive assisting you. The lab supervisor is a professor or a teaching assistant whom you may approach for clarifications on lab work, lab report submission, graded lab reports, etc. The lab executive is a technical staff whom you may approach for lab logistics (lab attendance, SQL Server account matter, lab submission deadline, computer problem, etc.).
- f) **AI tools**: NTU's policy on the use of AI tools: "The University requires students to (i) identify any generative AI tools used and (ii) declare how the tools are used in submitted work. Please note that even with acknowledgement, copying of output generated by AI tools (in part or whole) may still be regarded as plagiarism." Appendix D is to be submitted with each submission.

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 an 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 Appendix A and B. This includes background and general requirements of the application, conceptual information about the system and its users as well as a list of SQL queries that must be fulfilled as a minimum. Note that teamwork is required. Each team will 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 description, construct a suitable ER diagram. Analyze the choice of entity sets, different types of relationships required, the usage of weak entity sets, subclasses, etc. and compare them with alternative solutions from your team members. You need to submit the following, latest **three working days** after the first laboratory session:

- A PDF document of your ER diagram. A good ER diagram is one that is self-explanatory. If you believe certain parts of your ER diagram need explanation, you can include a written description (maximum one page). Combine both the ER diagram and the written explanation (if any) as a single PDF document, labeled as follows: Lab1_XXX_TeamY.pdf, where XXX is your lab group and Y is your team number. Marks are given for neat presentation of your ER diagram.
- Assessment for Lab 1 is based on whether the submitted ER diagram reflects correct understanding of ER diagram artefacts (entity sets, relationships, weak entities, subclasses, etc.) and whether they are used correctly and appropriately. Do note that not all information given in Appendix A can be represented in an ER diagram and more than one ER diagrams are possible. It is part of the project work for your team to submit what your team deems to be the best ER diagram among all possible ones.

4.2 Second Laboratory Session: Finalization of the ER Diagram

There is no submission for the second laboratory session. In this lab, each team should finalize their database design based on the feedback received from their lab supervisor and prepare for Lab 3. Please note that the second laboratory session is a free access session, i.e., attendance is not mandatory.

4.3 Third Laboratory Session: Generation of Normalized Database Schema

In this lab, you convert the ER diagram into relational schema and ensure that the relations are at least in 3NF. Follow the general guidelines covered during the lectures and tutorials to produce suitably normalized relations. For each relation, the key(s), primary key, and functional dependencies must be specified. If a

relation is generated due to the normalization of an original relation, then the normalization steps must be presented. You need to submit the following, latest **three working days** after the third laboratory session:

- A PDF document of the normalized database schema and FDs associated with each relation. Label the PDF document as: Lab3_XXX_TeamY.pdf, where XXX is your lab group and Y is your team number. If a relation created from the ER diagram violates 3NF, 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. (If relation is not in 3NF, perform the steps of the 3NF normalization.)

- Assessment for Lab 3 is based on whether the submitted report reflects correct understanding of keys in relations, identification of appropriate functional dependencies in each relation, how normalized relations are formed, and whether the normalizations are correctly and appropriately performed. Do note that in your final set of relations, the keys and functional dependencies in each relation may not be explicitly given in the description in Appendix A.

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

There is no submission for the fourth laboratory session. In this lab, the finalized database schema is to be implemented using SQL DDL commands. Your tables should be appropriately populated with sufficiently realistic records using SQL INSERT statements so that your query solution for Appendix B results in some meaningful output records (3 to 5) for each query. Your implementation should clearly incorporate the primary and foreign keys, data types, and any form of constraints. The lab provides MS SQL Server software for your implementation. You should start to work on the queries in Appendix B.

Please note that the fourth laboratory session is a free access session, i.e., attendance is not mandatory.

4.5 **Fifth Laboratory Session: Final demonstration**

In this lab, the implementation obtained from the previous laboratory session must now be extended to provide SQL query solutions for the queries in Appendix B. **At the end of the lab session**, you need to submit a single PDF document containing the followings:

- SQL DDL commands for table creation (from Lab 4).
- SQL statements to solve the queries in Appendix B and additional queries. Each query should be immediately followed by the query output. Briefly explain how the output is obtained.
- A printout of all table records.
- Description of any additional effort made.

Label the PDF document as: Lab5_XXX_TeamY.pdf, where XXX is your lab group and Y is your team number. You should prepare the PDF document in advance before coming to the lab. Some DDL commands may look like this:

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

In addition to the PDF document, you are to capture **screen recording** of query execution as a mp4 video file. For each query in Appendix B and additional queries, first show the SQL statement, then execute the query and show the query results, all recorded as a mp4 video file. Each query video should be no more than 30 seconds and labeled as: Lab5_XXX_TeamY_Q#.mp4 where # is the query number. Zip the PDF and all mp4 files into one single ZIP file.

During the lab session, you may be given additional queries to solve. In addition, your lab supervisor may require in-person live demonstration and Q&A. All team members are to actively contribute during the demonstration session and be familiar with **all aspects** of the project. No slide presentation is required.

APPENDIX A: PROJECT DESCRIPTION

MProps Digital Pte Ltd aims to develop an online platform that enables property agents to publish listings or advertisements (terms used interchangeably) for properties available for sale or rent. The platform also allows registered users to view the listings, contact the agent via a chat feature, make reservations or schedule an appointment for property viewings, and rate each other for successful deals.

However, MProps Digital does not have a professional in-house database designer. Consequently, the CTO of MProps has approached your company to design and develop a database that captures and stores the system's records. Your primary task is to meet the following requirements and incorporate the described data elements/fields below. The company welcomes your suggestions provided they are sensible and beneficial for the platform within the project's scope.

Message from CTO of MProps Digital Pte Ltd.

1. Our online platform will allow property agents to post advertisements/listings for property on sale or for rent. For each property, we hope to capture information such as the unit number, street name, postcode, size in square meters (sqm), type of property (apartment/condominium/landed), and whether the property is fully furnished, semi-furnished or unfurnished. Each listing will be assigned a unique ads_id and the date of creation will be captured as well. Only registered agents will be allowed to post and manage their listing.
2. For each registered agent, our system will record their name, NRIC (IC/passport number), contact number, email, password (hashed), license number, and license validity (dd-mm-yyyy). Each agent must be affiliate with only one agency. Whereas for each agency, our system will record the agency's name which is unique, a manager (who is an agent), and the year of establishment. Each agency must be comprised of at least two agents (including the manager).
3. If a listing is for sale, our system will capture the sales price, year built, and tenure. If the listing is for rent, the information such as if air conditioning and PUB (utilities) are included will be recorded. A property for rent can be intended for short-term rent or long-term rent. Our system will record the rate per day for short-term rent. As for long-term rent, our system will record the monthly rental rate, minimum stay (in months), and whether visitor are allowed.
4. A customer is a kind of system user who is interested in purchasing or renting a property. When customer register on our platform, they are required to provide their particular such as their name, NRIC (IC/passport number), contact number, email, password (hashed), and intention (to purchase, to rent, or both). When a customer views an advertisement, an engagement is created. The date and time of first viewing are recorded and stored in the viewing history log. The status of the listing will tag with "New" status for that particular customer. If the customer revisits the same listing again, the status will change to "viewed n times" and the new date and time of viewing will be appended to the viewing history log.
5. Customers can initiate a chat with the agent to enquiry about individual listing. When this happens, the status of the engagement will change to "in discussion". The timestamp and the chat content will be recorded for audit purpose. A separate chat instance will be created if the same customer initiates a chat with the same agent but on different listing.
6. Customers can use our platform to make an appointment requests with the agent to visit and view the actual properties (status: appointment requested). The agent can then decide to confirm or reject the

appointment (status: appointment confirmed/rejected). When the appointment is completed, either the customer or the agent can mark the appointment as “appointment completed”. Either party can also cancel the appointment and the status will be changed to “appointment cancelled”. All new appointments or changes in appointment status will be recorded in the appointment log with a timestamp, date and time of the appointment, status and action by (customer, agent, or system). A customer can make repeated appointment request as long as the agent is happy to accommodate, but this is limited to one appointment per day for the same customer, agent, and listing.

7. If a deal is on and completed for a listing (either for rent or on sale) the agent can mark the engagement as completed. Both parties can then rate each other and the information such as datetime, rating (1-5) and comment will be recorded in a review log.
8. To comply with local authority regulations, our system must record general information about property owner. This information includes the owner’s name, NRIC (IC/passport number), contact number, gender, and age. If a property has multiple owners, only the first owner’s information will be recorded.
9. Finally, the database should also support some queries listed in Appendix B.

Note: *The information above may not be complete. Some aspects of the database application’s details may have been omitted. It is expected that you come up with their own solution(s) in case of inconsistencies or missing information. However, you must keep track of these aspects and explain your assumptions in your submitted report. Extensions to the implementation of the basic system are encouraged.*

APPENDIX B: QUERIES

1. List the properties for sale in Ang Mo Kio that have 20 years or less remaining on their tenure.
2. Generate a statistic showing number of listings categorized by property type and furnished status between year 1 Jan 2022 to 31 Dec 2023.
3. Show the agency's name, manager's name, year, and the total sales amount for each agency by year. The total sales amount should reflect the cumulative property sales prices completed by respective agents. Arrange the list chronologically from the earliest year to the most recent and sort by sales amount in descending order within each year.
4. List all customer's name, email and their engagement information where they have initiated a chat with an agent, completed appointment, but have not completed the deal for rental listing. We would like to send them a follow-up message.
5. Identify the top three most engaging agents with a valid license for each year from 2020 to 2023. An engaging agent is defined as one who has completed the highest number of appointments, with each appointment having at least two chat messages. Completed appointments without chat messages should not be counted. For each agent, display their name, license validity, and affiliation.
6. Create a trigger to calculate the total views for all properties and update its engagement status accordingly.

Note: *if you find any of the above query(ies) cannot be generated, do explain and justify your rational. As these are part of the course assessment, you are not supposed to seek for your lab supervisor / TA helps to check the correctness of your solutions, for example, "is this the correct answer?" or "how many marks will be awarded for this solution?"*

APPENDIX C: INDIVIDUAL CONTRIBUTION FORM

Full Name	Individual Contribution to Lab 1 Submission	Percentage of Contribution	Signature

Full Name	Individual Contribution to Lab 3 Submission	Percentage of Contribution	Signature

Full Name	Individual Contribution to Lab 5 Submission	Percentage of Contribution	Signature

APPENDIX D: USE OF AI TOOL(S) IN LAB WORK

Each team member should indicate either A or B.

A. I affirm that my contribution(s) to the lab work is my own, produced without help from any AI tool(s)

B. I affirm that my contribution(s) to the lab work has been produced with the help from AI tool(s)

Full Name	Signature	Date	A or B

By signing this form, you declare that the above affirmation made is true and that you have read and understood NTU's policy on the use of AI tools.

If any team member answered B, the team member(s) must indicate and replicate the table below for every instance AI tool(s) is used.

Name of AI tool	<i>< For example, ChatGPT ></i>
Input prompt	<i>< Insert the question that you asked ChatGPT ></i>
Date generated	
Output generated	<i>< Insert the response verbatim from ChatGPT ></i>
Output screenshot	
Impact on submission	<i>< Briefly explain which part of your submitted work was ChatGPT's response applied ></i>