



MURANG'A UNIVERSITY OF TECHNOLOGY
SCHOOL OF COMPUTING AND INFORMATION
TECHNOLOGY

DEPARTMENT OF INFORMATION TECHNOLOGY

2023/2024 ACADEMIC YEAR

FIRST YEAR, FIRST SEMESTER EXAMINATION FOR MASTER OF
SCIENCE IN INFORMATION TECHNOLOGY
SIT 603: DATABASE DESIGN AND MANAGEMENT

DURATION: 3 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer ANY FOUR questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

QUESTION ONE (25 MARKS)

- a) Define the following concepts and provide an example for each
- i. Attribute (2 marks)
 - ii. Tuple (2 marks)
 - iii. One-to-many relationship (2 marks)
 - iv. Functional dependency (2 marks)
- b) A fundamental feature of a Database Management System (DBMs) is to support data independence. Using examples, explain how physical and logical independence is achieved in the three level ANSI SPARC database architecture. Discuss briefly why one of the two types of data dependence is harder to achieve than the other type. (8 marks)
- c) A data dictionary holds information that is crucial for the correct operation of a database. If the data dictionary is lost, the database cannot operate. Describe the contents of a typical data dictionary. (5 marks)
- d) Use relevant examples to distinguish between referential integrity and entity integrity. (4 marks)

QUESTION TWO (25 MARKS)

- a) Consider the following scenario for a garage selling and servicing cars and answer questions that follow.

The following rules describe the garage in more details:

- ✓ A customer engages with the garage either as a buyer by having their car(s) serviced (or both)
- ✓ A sales person may sell many cars, but each car is sold by only one salesperson
- ✓ Each salesperson or mechanic has a first name and last name
- ✓ Cars have a number plate, make and model as well as registration year.
- ✓ Customers have a first and last name as well as an address
- ✓ A customer may buy many cars, but each car is bought by only one customer. A sale takes place on specific date
- ✓ A salesperson writes a single invoice for each car he or she sells
- ✓ A customer receives an invoice for each car he or she buys

- ✓ When a customer takes one or more cars in for repair or service, one service ticket is written for each car. A service takes place on a specific date and customer receives comments on what has been done
- ✓ A car brought in for service can be worked on by many mechanics, and each mechanic may work on many cars. Each mechanic spends a certain amount of time on a job called an assignment, and has an associated rate

Required:

Draw an entity relationship diagram for car dealership scenario. Your answer must show the entities and their relationships. Cardinalities and optionality between entities must be shown. State any additional assumptions you make. (15 marks)

- b) Explain how data is physically stored and accessed in the following approaches
 - i. Relational databases (5 marks)
 - ii. Object-oriented databases (5marks)

QUESTION THREE (25 MARKS)

- a) Explain the concept of checkpoints and describe, using a timeline diagram, how checkpoints are used to recover a database following failure of a transaction sequence. (7 marks)
- b) Briefly describe how databases can recover from the following types of failure:
 - i. System failure (loss of entire machine/servers). Often due to power outage. (4 marks)
 - ii. Catastrophic failure such as loss of entire installation/building. (4 marks)
- c) Transactions that apply the two phase locking (2PL) protocol can be affected by a situation known as deadlock.
 - i. Using an example, explain how deadlock can occur. (2 marks)
 - ii. Briefly explain how a deadlock situation can be resolved. (2 marks)
- d) Describe the three security measures and precautions that a DBA (Database administrator) must have in place to prevent the database from being subject to hacking, for example, someone trying to steal data. (6 marks)

QUESTION FOUR (25 MARKS)

- a) A company sells garden furniture. It has decided to create a relational database. At first, incomplete design includes two tables PRODUCT and ORDER

PRODUCT (ProductID, Producttype, size, price,)

ORDER (OrderID, OrderDate, ProductID, ...)

For example, the product which has ProductID 12345 is a large bench which has a price of Ksh. 1500

- i. State one additional piece of data which should be included in PRODUCT and give one reason why it is needed. (2 marks)
- ii. A customer table is added. An entity-relationship (E-R) diagram is shown



Explain why this design would be inefficient for customer. (3 marks)

- iii. Some of the structured query language for this database is

```
SELECT    surname, title, PhoneNo
FROM      CUSTOMER
WHERE     Town = 'Coventry'
ORDER BY  Surname
```

Describe the purpose of this code and give one situation in which it may be used. (6 marks)

- b) Every bank account has an account number sort code. The sort code identifies the bank branch (location of the bank) with which the account is held and the account number uniquely identifies the bank account. An extract from the bank's database table is as shown below

Customer ID	First name	Surname	Acc. No	Sort code	Branch name
145204	Elaine	Kyalo	14725200	67-54-56	Thika
657875	Jordan	Ouma	62703441	67-45-67	Juja
735951	Monim	Njeri	96385547	67-00-11	Ruiru
744078	Tom	Mwangi	45623929	67-00-11	Ruiru

- i. Explain why the above table is not in the third normal form. (2 marks)
- ii. Describe how the database could be put into third normal. (6 marks)
- iii. Write an SQL command to create a table student (RNo, name, marks, dept.) with proper data types and RNo as primary key. (6 marks)

QUESTION FIVE (25 MARKS)

- a) It is widely acknowledged that relational database management systems cannot always support the rapid growth in data storage. Give brief comments on why this view is often taken. (5 marks)
- b) One method of storing big data is within key-value pairs. Explain key-value pairs and give one scenario in which the use of key-value pairs would be applicable. (5 marks)
- c) Explain the following three characteristics of Brewer's CAP theorem and show how they relate to big data management.
 - i. Consistency (3 marks)
 - ii. Availability (3 marks)
 - iii. Partition tolerance (3 marks)
- d) Discuss any three challenges for data processing and storage management in big data. (6 marks)