



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Engineering, Built Environment & Information
Technology

Department of Computer Science

COS326 - Database Systems

Online Initial Examination

Total Marks: 100

17 November 2022

Time/Duration: 8:00am - 11:00am (3 Hours 0 Minutes)

Examiner: Mr. S.M. Makura

Instructions

1. Read the question paper carefully and answer all the questions.
2. This examination comprises of **36** questions. It consists of three sections, namely Section A (Multiple Choice & Fill in the blank questions) – 20 marks, Section B (Application and Theory - Based Questions) – 40 Marks, Section C (Scenario-Based questions) - 40 Marks.
3. You have **150** minutes to complete this semester test.
4. This is a **closed book** examination: you may therefore **not** have any study material with you.
5. Please switch off your smartphone/tablet and keep it off for the duration of the semester test.

6. The examination will automatically submit your answers when the time (3 hours) expires. You can also submit the examination yourself if you are done ahead of time.
7. All examination regulations and ‘code of conduct’ of the University of Pretoria are applicable during this examination.

Integrity Statement:

The University of Pretoria commits itself to produce academic work of integrity. I affirm that I am aware of and have read the Rules and Policies of the University, more specifically the Disciplinary Procedure and the Tests and Examinations Rules, which prohibit any unethical, dishonest or improper conduct during tests, assignments, examinations and/or any other forms of assessment. I am aware that no student or any other person may assist or attempt to assist another student, or obtain help, or attempt to obtain help from another student or any other person during tests, assessments, assignments, examinations and/or any other forms of assessment.

Section A: Multiple Choice and Fill in the Blanks Questions (20 Marks)

Question 1

(1 Mark)

Which one of the following classes would you use to connect to the ObjectDB database?

- a. Query
- b. TypedQuery
- c. EntityManager
- d. Serializable

Question 2

(1 Mark)

Given that the following SQL statements have been executed on a PostgreSQL database:

```
CREATE TYPE InventoryItem AS ( name text, supplierID
char(5), unitPrice numeric);
CREATE TABLE StockOnHand ( item inventoryItem, quantity
integer);

CREATE FUNCTION stockValue( inventoryItem, integer ) RETURNS
numeric AS
dollar dollar
    SELECT dollar 1.unitPrice * dollar 2    AS stockValue;
dollar dollar LANGUAGE SQL;
```

Which one of the following SELECT statements will produce a list of stock items on hand and the stock value, from the stockOnHand table?

a.

```
SELECT    item.name AS item_name, item.supplierID AS supplier,
          item.unitPrice AS unit_price, quantity, stockValue(item, quantity)
FROM      stockOnHand;
```

b.

```

SELECT  (stockOnHand.item).name AS item_name,
        (stockOnHand.item).supplierID AS supplier,
        (stockOnHand.item).unitPrice AS unit_price,
        quantity, stockValue(item, quantity)

FROM    stockOnHand;

```

c.

```

SELECT  name AS item_name, supplierID AS supplier,
        unitPrice AS unit_price, quantity,
        stockValue(item, quantity)

FROM    stockOnHand;

```

d.

```

SELECT  item.name AS item_name, item.supplierID AS supplier,
        item.unitPrice AS unit_price, item.quantity, item.stockValue(item,
quantity)

FROM    stockOnHand;

```

Question 3

(1 Mark)

Study the following XML document and answer the question that follows:

```

<STAFFLIST>
<STAFF branchNo = "B005">
  <STAFFNO>SL21</STAFFNO>
  <NAME>
    <FNAME>John</FNAME><LNAME>Green</LNAME>
  </NAME>
  <SALARY>30000</SALARY>
</STAFF>
<STAFF branchNo = "B003">
  <STAFFNO>SG37</STAFFNO>
  <NAME>
    <FNAME>Ann</FNAME><LNAME>Brown</LNAME>
  </NAME>
  <SALARY>12000</SALARY>
</STAFF>
</STAFFLIST>

```

Which one of the following FLWOR queries below will list the staff names and staff numbers of all staff in ascending order of staff number?

a.

```
for dollar s in //STAFF
let dollar snum    :=    /STAFFNO
let dollar fn      :=    /NAME/FNAME
let dollar ln      :=    /NAME/LNAME
order by          /STAFFNO ascending
return            <STAFFDATA>
                    <STAFFNO>{ dollar snum/text() }</STAFFNO>
                    <FNAME>{ dollar fn/text() }</FNAME>
                    <LNAME>{ dollar ln/text() }</LNAME>
                </STAFFDATA>
```

b.

```
let dollar snum    :=    /STAFFNO
let dollar fn      :=    /NAME/FNAME
let dollar ln      :=    /NAME/LNAME
order by          /STAFFNO ascending
return            dollar snum/text(), dollar fn/text(), dollar ln/text()
```

c.

```
for dollar s in //STAFF
let dollar snum    :=    dollar s/STAFFNO
let dollar fn      :=    dollar s/NAME/FNAME
let dollar ln      :=    dollar s/NAME/LNAME
order by dollar s/STAFFNO ascending
return            <STAFFDATA>
                    <STAFFNO>{dollar snum/text() }</STAFFNO>
                    <FNAME>{dollar fn/text() }</FNAME>
                    <LNAME>{dollar ln/text() }</LNAME>
                </STAFFDATA>
```

d.

```
for dollar s in //STAFF
let dollar snum    :=    s/STAFFNO
let dollar fn      :=    s/NAME/FNAME
let dollar ln      :=    s/NAME/LNAME
```

```

order by s/STAFFNO ascending
return      <STAFFDATA>
            <STAFFNO>{ dollar.snum/text() }</STAFFNO>
            <FNAME>{ dollar.fn/text() }</FNAME>
            <LNAME>{ dollar.ln/text() }</LNAME>
        </STAFFDATA>

```

Question 4

(1 Mark)

Study the following collection (called mydatabasesCollection) from a MongoDB database called mydb and answer the question that follows:

```

{
  _id: ObjectId(7df78ad8902c)
  title: 'Cassandra Overview',
  description: 'Cassandra is a NoSql database',
  tags: ['Cassandra', 'database', 'NoSQL'],
  likes: 100
},
{
  _id: ObjectId(7df78ad8902d)
  title: 'NoSQL Overview',
  description: 'NoSql database is very fast',
  tags: ['mongodb', 'neo4j', 'database', 'NoSQL'],
  likes: 200
},
{
  _id: ObjectId(7df78ad8902e)
  title: 'VoltDB Overview',
  description: 'VoltDB is a New sql database',
  tags: ['VoltDB', 'database', 'New SQL'],
  likes: 750
}

```

It is now required to write the JavaScript statement for the mongo shell to compute and display the total number of likes for all documents in the collection mydatabasesCollection with the title 'NoSQL Overview'.

Which one of the statements below will perform the required task?

a.

use mydb

mydb. mydatabasesCollection.aggregate(

[

```

    { dollar match: {title:"NoSQL Overview"} },
    { dollar group:

```

```

        {__id: "dollar title", num_likes: { dollar sum :
"dollar likes"} }
    }
] )

```

b.

```

use mydb
mydb. mydatabasesCollection.aggregate(
    [
        { dollar match: {title:"NoSQL Overview"} },
        { dollar group by:
            {__id: "dollar title", num_likes: { dollar sum : "dollar likes"} }
        }
    ] )

```

c.

```

use mydb
mydb. mydatabasesCollection.aggregate(
    [
        { dollar match: {title:"NoSQL Overview"} },
        { dollar group:
            {__id: "dollar title", num_likes: { dollar add : "dollar likes"}
        }
    ] )

```

d.

```

use mydb
mydb.mydatabasesCollection.aggregate(
    [
        { dollar : {match.title:"NoSQL Overview"} },
        { dollar group:
            {__id: "dollar title", num_likes: { dollar add : "dollar likes"}
        }
    ] )

```

Question 5**(1 Mark)**

In MongoDB, you can insert multiple documents using the _____ method

- a. save
- b. insertMany
- c. saveMany
- d. insertOne

Question 6**(1 Mark)**

Given that the following Cypher query has been executed on a Neo4j graph database:

```
CREATE
    (psT:Person { name: "Thandi", from: "Durban",
    hobby: "singing" } ),
    (psJ:Person { name: "Johan", from: "Pretoria",
    hobby: "surfing" } ),
    (psN:Person { name: "Neo", from: "Tshwane",
    hobby: "soccer" } ),
    (psT)-[:FOLLOWS { since: 2017 } ]->(psJ ),
    (psT)-[:FOLLOWS { since: 2016 } ]->(psN ),
    (psJ)-[:FOLLOWS { since: 2018 } ]->(psT )
    (psJ)-[:FOLLOWS { since: 2018 } ]->(psN )
```

Which one of the following queries will display the details of the persons that Johan follows?

a.

```
MATCH (psT {name: "Johan"} )-[:FOLLOWS]-> (followed)
      RETURN name, from, hobby;
```

b.

```
MATCH (psT {name: "Johan"} )-[:FOLLOWS]-> (followed)
      RETURN followed.name, followed.from, followed.hobby;
```

c.


```
MATCH (psT {name = "Johan"} )-[:FOLLOWS]-> (followed)

RETURN psT.name, psT.from, psT.hobby;
```

d.

```
MATCH (psT {name = "Johan"} FOLLOWS -> (followed)

RETURN psT.name, psT.from, psT.hobby;
```

Question 7

(1 Mark)

Given that the following Cypher query has been executed on a Neo4j graph database:

```
CREATE
  ( psX:Person { name: "Xolisa", from: "Joburg" } ),
  ( psK:Person { name: "Katlego", from: "Pretoria"} ),
  ( cb1:Club { name: "Sundowns" } ),
  ( cb2:Club { name: "Kaizer Chiefs"}),

  ( psX)-[:KNOWS { since: 2014 } ]->(psJ ),
  ( psX)-[:SUPPORTS { since: 2015 } ]->(cb1 ),
  ( psK)-[:SUPPORTS { since: 2014 } ]->(cb2 );
```

Which one of the following CYPHER queries will display the names of the ‘Persons’ who support the Sundowns Club as well as the club name?

a.

```
MATCH (psx)-[:SUPPORTS]->(clb)

WHERE clb.name = "Sundowns"

RETURN psx, clb;
```

b.

```
MATCH (psx: Person)-[R]->(clb:Club)

WHERE (R = SUPPORTS) AND (clb.name = "Sundowns" )

RETURN psx.name, clb.name
```

c.

MATCH (psx: Person)-[:SUPPORTS]->(clb:Club)

WHERE clb.name = "Sundowns"

RETURN psx.name, clb.name

d.

MATCH psx: Person -[:SUPPORTS]->(psx.clb:Club)

WHERE clb.name = "Sundowns"

RETURN psx.name, clb.name

Question 8

(1 Mark)

Identify the correct option which defines a Datamart:

- a. A subgroup of the data warehouse
- b. Another type of data warehouse
- c. Not related to data warehouse
- d. A warehouse is contained within a Datamart

Question 9

(1 Mark)

The data is stored, retrieved & updated in _____.

- A. OLAP.
- B. OLTP.
- C. SMTP.
- D. FTP.

Question 10

(1 Mark)

Which one of the following is not a data modelling technique?

- a. Descriptive

- b. Predictive
- c. Partitioning
- d. Time series

Question 11

(1 Mark)

You have a Student entity class. Type in the method you would use to store an instance of the student entity class in the ObjectDB database_____

Note: Type in the name of the method only

Question 12

(1 Mark)

In the SQL:2011 standard, PSM stands for _____

Question 13

(1 Mark)

Study the following FLWOR query and answer the question that follow:

```
for dollarB in distinct-values (//@branchNo)
let dollarS := //STAFF[@branchNo = dollarB]
    where some dollarsal in dollarS/SALARY
        satisfies (dollarsal > 15000)

return <BRANCHNO>{ dollarB}</BRANCHNO>
```

The key word, "some" refers to a/an _____ qualifier.

Question 14

(1 Mark)

To delete a collection in a MongoDB database you use the _____ method

Note: Type in the name of the method only.

Question 15

(1 Mark)

In MongoDB database, you use the wildcard specifier _____ to index all fields in the collection that contain string content.

Question 16 (1 Mark)

In the property graph model, information is modelled using three basic building blocks namely node, relationship and _____

Question 17 (1 Mark)

In Neo4j, you use the _____ clause for updating labels on nodes and properties on nodes and relationships.

Question 18 (1 Mark)

NuoDB is an example of a _____ database.

Question 19 (1 Mark)

_____ is a subset of business intelligence (BI) functionality that encompasses mathematical, statistical, and modelling techniques used to extract knowledge from data.

Question 20 (1 Mark)

In OLAP, the RANK and _____ functions are used to compute the rank of a record compared to other records in the dataset based on the values of a set of measures.

Section B: Application and Theory-Based Questions (40 Marks)

Question 21

(3 Marks)

Object ODBMS

Given an instance of EntityManagerFactory called mydb, write the Java code that you would use to create an ObjectDB database called COS326.

Question 22

(3 Marks)

Object Relational DBMS

Study the following SQL statements and answer the question which follows.

```
CREATE TYPE TitleType AS ENUM
('Prof','Dr','Ms','Mev','Miss','Mr','Mnr',);
CREATE TYPE StaffType AS (title TitleType, firstName
CHAR(20), surname CHAR(20));
CREATE TABLE staffMember (staff StaffType, department
CHAR(20));
```

Write the SQL function called StaffName which returns a string with the title, first name and last name of a staff member.

Question 23

(3 Marks)

Semi-structured data & XML

Study the following XML document and answer the following question:

```
<STAFFLIST>
<STAFF branchNo = "B005">
  <STAFFNO>SL21</STAFFNO>
  <NAME>
    <FNAME>John</FNAME><LNAME>Green</LNAME>
  </NAME>
  <SALARY>30000</SALARY>
</STAFF>
<STAFF branchNo = "B003">
  <STAFFNO>SG37</STAFFNO>
  <NAME>
    <FNAME>Ann</FNAME><LNAME>Brown</LNAME>
  </NAME>
  <SALARY>12000</SALARY>
```

```
</STAFF>
</STAFFLIST>
```

Write the XPath expression to show the staff number and name of all staff who work at branch number B003.

Question 24

(6 Marks)

MongoDB

Study the following collection (called myblogsCollection) from a MongoDB Database called mydb and answer the questions that follow:

```
{
  _id: ObjectId(7df78ad8905t)
  title:'Facebook',
  likes:100
},
{
  _id:ObjectId(7df78ad8905y)
  title: 'Twitter',
  likes:200
},
{
  _id: ObjectId(7df78ad8907g)
  title:'TikTok',
  likes: 750
},
{
  _id:ObjectId(7df78ad8905f)
  title:  'Instagram',
  likes:200
},
{
  _id: ObjectId(7df78ad8905p)
  title:'Facebook',
  likes:150
},
{
  _id: ObjectId(7df78ad8905l)
  title:'Facebook',
  likes:200
},
{
```

```
{
  _id: ObjectId('7df78ad8907x')
  title: 'TikTok',
  likes: 50
},
```

- a. Write the JavaScript statement for the mongo shell to list all documents which have the title “Facebook” (2 marks).
- b. Write the JavaScript statement for the mongo shell to compute total number of ‘likes’ for the documents & show results in ascending order of number of likes, and only those with a total greater than 300 (4 Marks).

Question 25

(6 Marks)

Neo4j

Study the following CYPHER query and answer the questions that follow:

```
CREATE
  ( psT:Person { name: "Thandi", from: "Durban",  hobby:
"singing" }  ),
  ( psJ:Person { name: "Johan", from: "Pretoria",  hobby:
"surfing" }  ),
  (psN:Person { name: "Naledi", from: "Bloemfontein",
hobby: "soccer" }  ),
  (psT)-[:FOLLOWS { since: 2017 } ]->(psJ),
  (psT)-[:FOLLOWS { since: 2016 } ]->(psN),
  (psJ)-[:FOLLOWS { since: 2018 } ]->(psT)
```

- a. Write the CYPHER query to update the Thandi node with a new property called age with value 24. (3 Marks)
- b. Write the CYPHER query to count the number of persons who have at least one follower (3 marks)

Question 26

(6 Marks)

Data warehousing

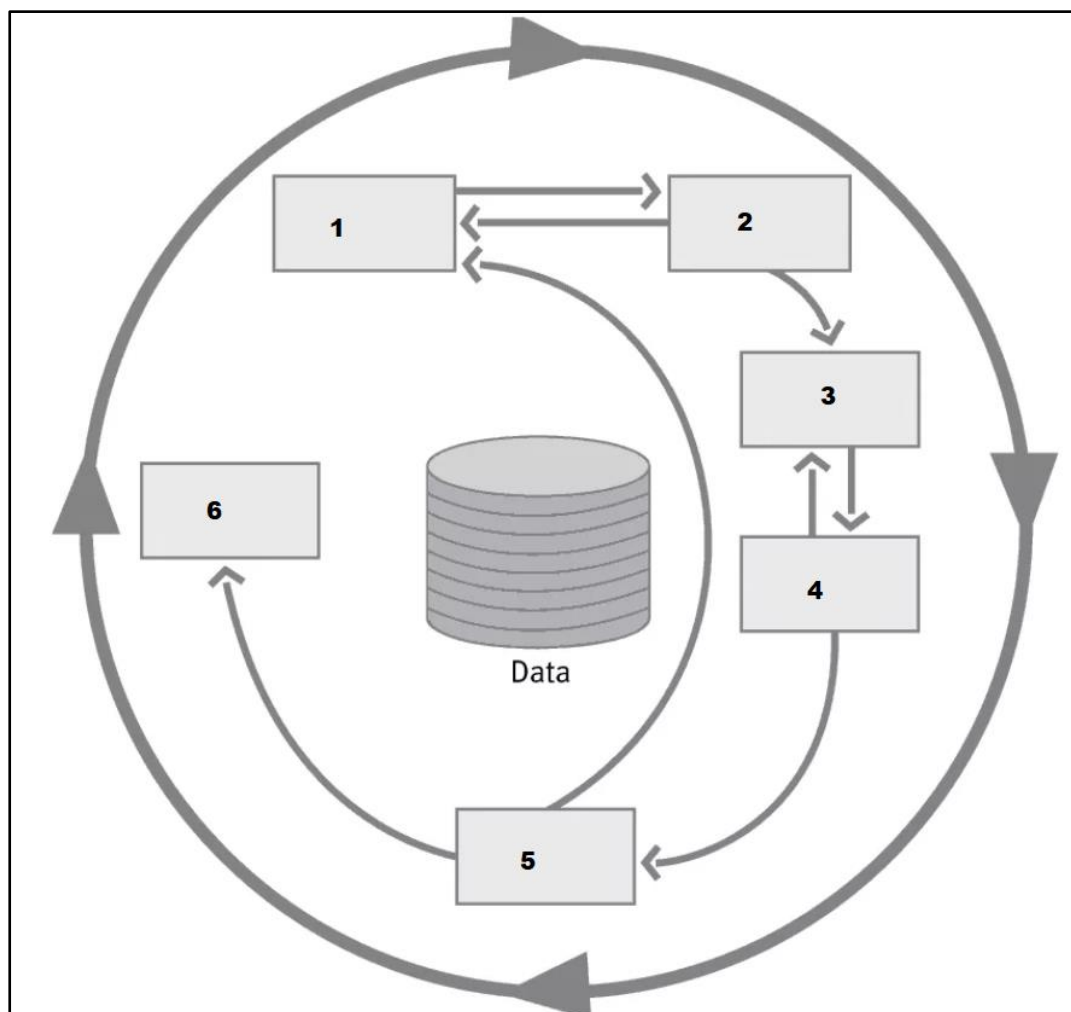
With an aid of an example, describe the Star Schema.

Question 27**(6 Marks)****OLAP**

Name and describe with an aid of a SQL query example of any SQL extension for aggregation you know of.

Question 28**(6 Marks)****Data Mining**

Study the following figure and answer the question that follow:



State the names of the phases (1 to 6) of the above CRISP-DM process.

Section C: Scenario-Based Questions

(40 Marks)

Question 29

(3 Marks)

Object ODBMS

Study the following scenario and the following question:

You have been called for a software developer interview at XYZ software solutions. In the interview, you had mentioned that you studied and utilised Object-Oriented databases. The interview panel then decided to test your proficiency in using Object-Oriented databases.

Source: Makura S.M (2022)

Explain to the interview panel with an aid of a Java code example, what the TypedQuery interface is and its functions in Object-Oriented Databases.

Question 30

(4 Marks)

Object RDBMS

Study the following scenario and the following question:

This scenario builds up from the scenario in Question 29. You are still in the interview at XYZ software solutions. You had also mentioned that you studied and used Object RDMS. The interview panel have then decided to test your proficiency again in using Object RDMS. They provide you with the following trigger function:

```
CREATE FUNCTION delete_audit() RETURNS TRIGGER AS
dollardollar BEGIN
    INSERT INTO DeletedBooking SELECT OLD*, today,
now, user;
    RETURN OLD;
END
dollardollar LANGUAGE plpgsql;
```

Source: Makura S.M (2022)

- (a) Explain in detail to the interview panel what the function does? (2 Marks)
- (b) Create a trigger statement so that the function of (a) above is used to perform the necessary actions after a row is deleted from the specified table (2 Marks)

Question 31**(3 Marks)****Semi structured Data & XML**

Study the following scenario and the following question:

You have been invited by Bright Minds High School to provide a presentation to pupils studying Computer Applications and Technology on how you would use BaseX to run queries. You have been provided the following XML file called **students.xml**.

students.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<students>
  <student module = "COS326">
    <name>Sheunesu Makura</name>
    <age> 18 </age>
  </student>
  <student module = "COS333">
    <name>Thando Mandela</name>
    <age> 21 </age>
  </student>
  <student module = "COS735">
    <name>Palesa Mohlare</name>
    <age> 25 </age>
  </student>
  <student module = "COS151">
    <name>Andries van der Merwe</name>
    <age> 19 </age>
  </student>
  <student module = "COS223">
    <name>Xolisa Phila</name>
    <age> 23 </age>
  </student>
  <student module = "COS301">
    <name>Ndivhuwo Makhado</name>
    <age> 24 </age>
  </student>
  <student module = "COS721">
    <name>Tshifhiwa Ndou</name>
    <age> 22 </age>
  </student>
  <student module = "COS122">
    <name>Marianne Jordaan</name>
    <age> 28 </age>
  </student>
  <student module = "COS216">
```

```
<name>Thulasizwe Nkandla</name>
<age> 20 </age>
</student>
<student module = "COS314">
<name>Avinash Panday</name>
<age> 23 </age>
</student>
</students>
```

Source: Makura S.M (2022)

Assuming that the above XML file has already been imported into BaseX, write a FLWOR query to list the student names studying third year modules whose age is less than 22 (3 Marks)

Question 32

(6 Marks)

MongoDB

Study the following scenario and the following questions:

You have a friend studying MongoDB. Your friend has showed you the following collection called **myfavourites** within MongoDB:

```
{ _id: 5, type: "food", item: "cake", ratings: [5, 8, 9 ] }
{ _id: 6, type: "food", item: "chicken", ratings: [5, 9 ] }
{ _id: 7, type: "food", item: "biscuits", ratings: [9, 5, 8 ] }
}
{ _id: 8, type: "food", item: "steak", ratings: [5, 8, 9 ] }
```

The name of the MongoDB database is called **foods**. Assist your friend in answering the following questions:

Source: Makura S.M (2022)

Write the JavaScript statement for the mongo shell that does the following:

- List all documents where the field 'ratings' holds exactly three elements, 5, 8, 9, in this order (2 Marks)
- List all documents where 'ratings' contains 5 as one of its elements (1 Mark)

- c. List all documents where the ratings array contains at least one element that is greater than 5 and less than 9: (3 Marks)

Question 33

(6 Marks)

Neo4j

Study the following scenario and the following questions:

You have been provided with the following Cypher query:

```
CREATE
    ( psX:Person { name: "Xolisa", from: "Joburg" } ),
    ( psK:Person { name: "Katlego", from: "Pretoria" } ),
    ( cb1:Club { name: "Sundowns" } ),
    ( cb2:Club { name: "Kaizer Chiefs" } ),

    ( psX)-[:KNOWS { since: 2014 } ]->(psJ ),
    ( psX)-[:SUPPORTS { since: 2015 } ]->(cb1 ),
    ( psK)-[:SUPPORTS { since: 2014 } ]->(cb2 );
```

Assuming that the above query has been already executed in a Neo4j database, use this information to answer the following questions.

Source: Makura S.M (2022)

- a. Write the CYPHER query to update the nodes for clubs with a new property called points with values 25 (for Sundowns), and 20 (for Kaizer Chiefs). (3 Marks)
- b. Write the CYPHER query that utilises a mathematical function that calculates the difference between the points of Sundowns and Kaizer Chiefs. (3 Marks)

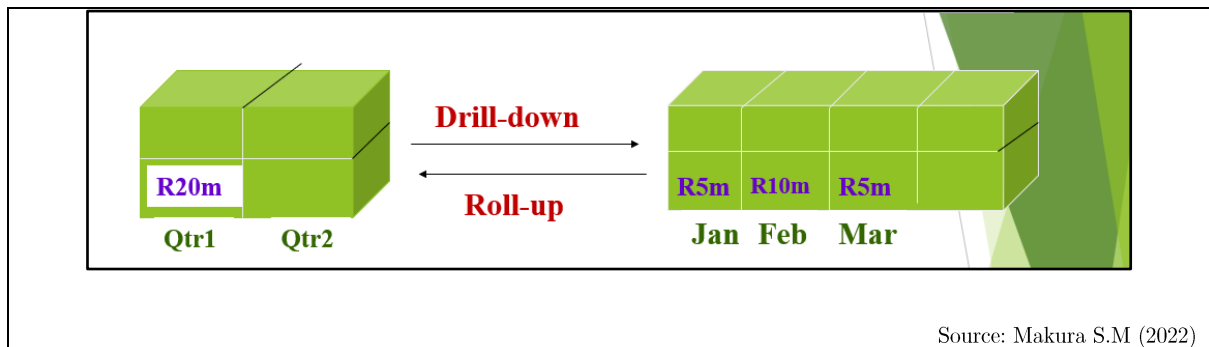
Question 34

(6 Marks)

Data warehousing

Study the following scenario and the following questions:

A local firm utilises data warehousing. You have been provided by the firm with the following figure which explains some of their business operations.



- What is the name of the shape depicted in the figure above in terms of data warehousing? (2 Marks)
- Describe in detail the two operations shown in figure. Include the values shown in the figure your description (4 Marks)

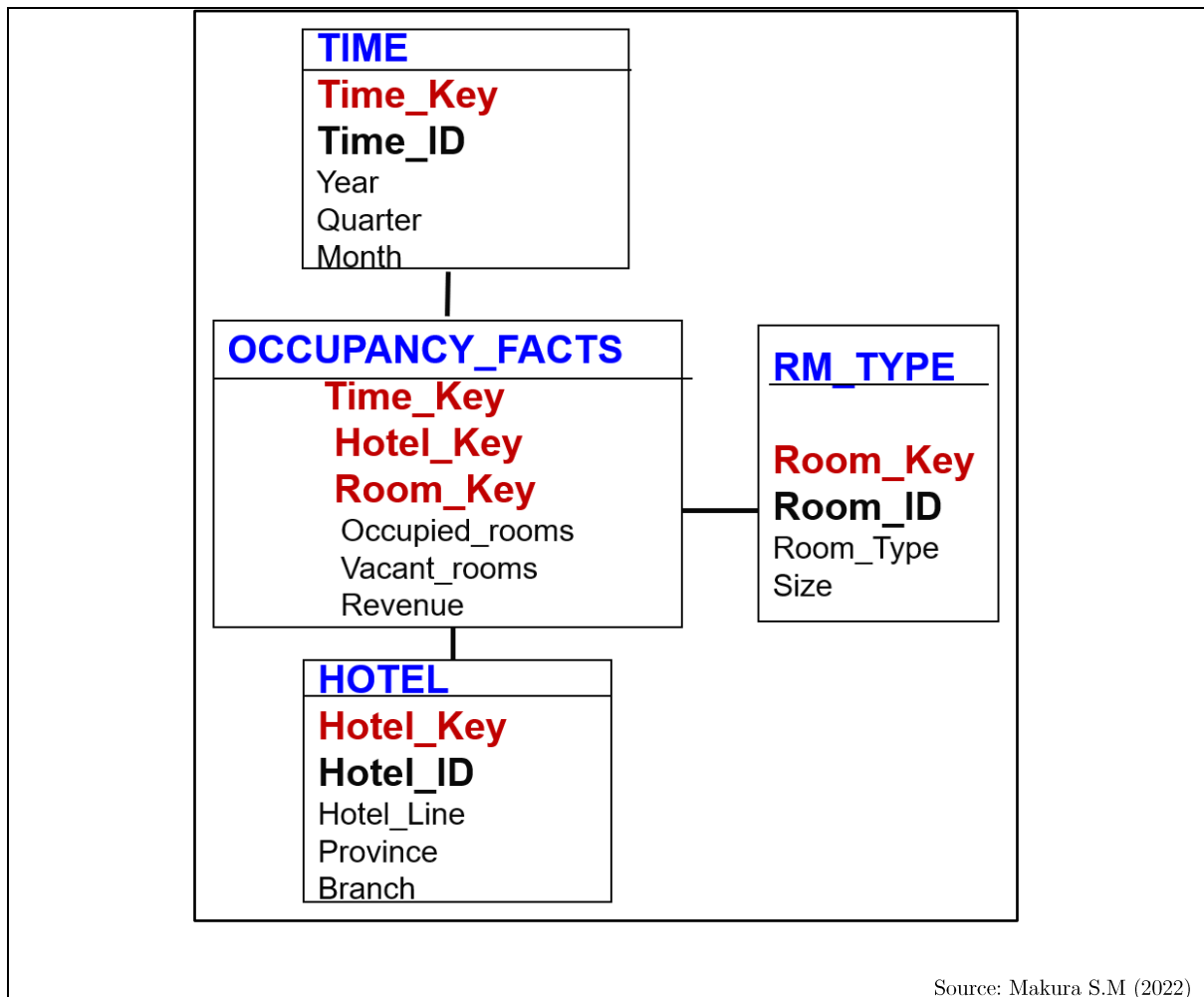
Question 35

(6 Marks)

OLAP

Study the following scenario and the following question:

ABC Hotel is a hotel and leisure company with hotels throughout South Africa. They utilise OLAP and ROLAP in their business operations. Below is a schema for the hotel occupancy Datamart:



The company's management board has asked you as a data mining specialist to generate aggregation reports with the following groupings:

$\{province, month, SUM\}$, $\{province, SUM\}$, $\{month, SUM\}$, $\{all, SUM\}$

using one SQL statement.

Complete the following SQL statement for generating the required reports.

SELECT H.province, T.month, SUM(C.revenue) AS revenue_sum

FROM _____

WHERE R. Room_Type = 'single' AND

T.year = 2022

_____ AND

_____ AND

_____ AND

GROUP BY CUBE (_____);

Question 36

(6 Marks)

Data Mining

Study the following scenario and the following question:

You have been provided with the following data matrix:

Age	Gender	Income	Dependants	Credit-Risk
24	male	200 000	1	low
32	female	300 000	4	medium
54	male	400 000	5	high
62	female	500 000	10	low

Source: Makura S.M (2022)

- Name and describe the two types of predictive models. (4 Marks)
- Using the data matrix in the scenario above, identify the variables of each of the two types of predictive models you have identified and described in (a) above. (2 Marks)

End of examination paper