THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

This exam paper must not be removed from the venue

Venue ____________________
Seat Number __________
Student Number |__|__|__|__|__|__|__|__|
Family Name ____________________
First Name ____________________

School of Electrical Engineering & Computer Science

Semester One Examinations, 2024

INFS1200 / INFS7900 Introduction to Information Systems

This paper is for St Lucia Campus students.

Examination Duration: 120 minutes

Planning Time: 10 minutes

Exam Conditions:

- •Specified written or printed material permitted
- •No calculators permitted
- •During Planning Time - Students are encouraged to review and plan responses to the exam questions

Materials Permitted in the Exam Venue:
(No electronic aids are permitted e.g. laptops, phones)

One A4 sheet of handwritten or typed notes double sided is permitted

Materials to be supplied to Students:
Additional exam materials (e.g. answer booklets, rough paper) will be provided upon request.

None

Instructions to Students:
If you believe there is missing or incorrect information impacting your ability to answer any question, please state this when writing your answer.

Complete all answers on the exam paper in the spaces provided

For Examiner Use Only

Question	Mark

Total _________

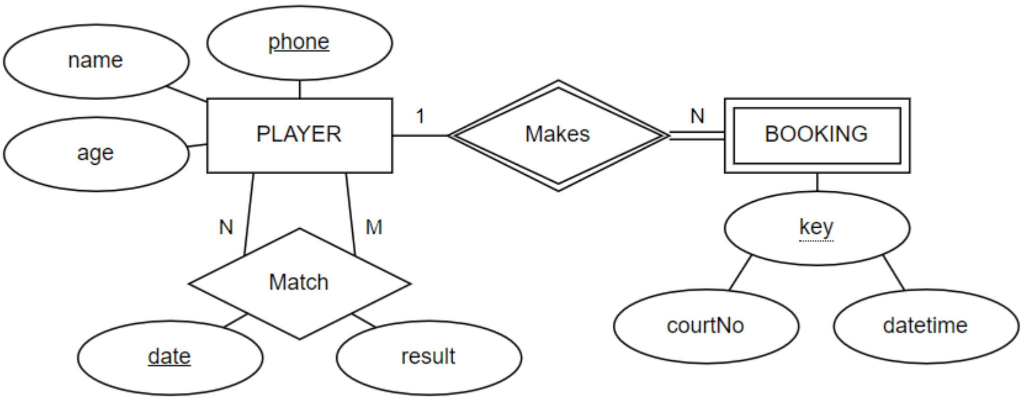
Question 0 **(0 marks)**

Please write your student ID number (SID) on the bottom of every odd page in the space provided.

Module 0 and 1 – Database Management Systems and Conceptual Data Modelling (10 marks)

Question 1 **(6 marks)**

Consider the following data model of a squash court booking and results database:



Select all of the following that are implied by the ER diagram (each will be marked as a true or false question):

□ Each match is played by two players.

□ The primary key for a booking is the combination of CourtNo and a datetime timestamp.

□ Players must have a phone number recorded.

□ All match results must be recorded.

□ A player can have reserved at most one booking at a time.

□ A player’s name comprises their first name and second name.

Question 2 **(4 marks)**

You are to design an OH&S database to store information about staff Occupational Health and Safety training courses, the OH&S courses staff have taken, and the time since a staff member last completed a course. Some relevant details are:

- Staff are represented by their (unique) staff ID and their name.
- Courses have a mandatoryFor code, indicating for which groups of staff this training is mandatory, as well as a number and a title. For example, the course with tuple (*“AS”, 001, “Basic Fire Safety"*) has the mandatoryFor code "AS" (i.e. standing for "all staff"), number 001, and title "Basic Fire Safety”.
- For each mandatoryFor code, a course has a unique number, but the same number may appear with different mandatoryFor codes.
- The date that a staff member last completed the course is stored with the ID of the staff member and the course primary key

If you were to draw an E/R diagram to represent this database structure correctly, select all of the following that you would find in a correct E/R diagram.

☐ An entity COURSES with attributes ‘mandatoryFor’ and ‘number’ underlined, and the attribute ‘title’ not underlined.

☐ A relationship COURSE_KEY with a composite attribute representing its key.

☐ An entity STAFF with attribute ‘ID’ not underlined and ‘name’ underlined.

☐ An entity LASTCOMPLETED with attributes ‘staffID’, ‘mandatoryFor’, ‘cNumber’, and ‘date’.

Module 2 – The Relational Data Model (15 marks)

Question 3 (5 marks)

Project details are stored by an engineering firm in a database that uses the following relational schema:

TEAMMEMBER[MemberID, Name, DOB]
PROJECT[ProjectID, Title, Summary, Completed]
ROLE[ProjectID, MemberID , Role]

ROLE.ProjectID references PROJECT.ProjectID
ROLE.MemberID references TEAMMEMBER.MemberID

TEAMMEMBER		
MemberID	**Name**	**DOB**
2193	Johannes Susanto	1976-04-26
2515	Markus Stein	1982-06-12
6234	Wendy Jennings	NULL
2346	Xue Liu	1991-08-14

PROJECT			
ProjectID	**Title**	**Summary**	**Completed**
272	Splash co.	Retail website redesign	2023-07-31
238	Dept of Energy	Solar farm registry	2024-04-19
263	Big Corp.	Payroll system upgrade	2022-01-03

ROLE		
ProjectID	**MemberID**	**Role**
272	2346	Project Lead
238	2193	Senior Engineer
263	2515	Engineer
272	2515	Engineer

Select all options that result in a violation:

□ Insert the tuple <2346, “Carlos Santiago”, NULL> into the TEAMMEMBER table.

□ Insert the tuple <245, 2193, “Senior Developer”> into the ROLE table.

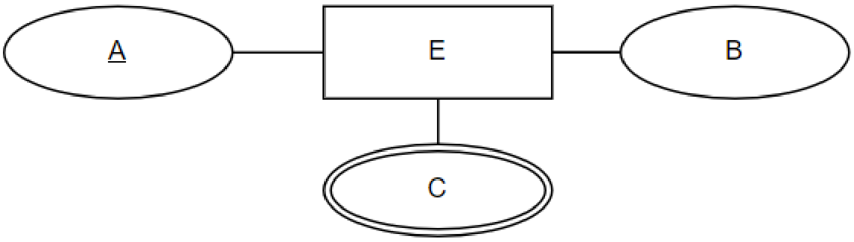
□ Insert the tuple <272, 6234, “Project Lead”> into the ROLE table.

□ Delete the tuple with ProjectID 238 from the PROJECT table (assume all on delete is set to default).

□ Update the tuple <263, 2515, “Engineer”> to <263, 2515, “Senior Engineer”> in the ROLE table.

Question 4 **(2 marks)**

Consider the following ER diagram:



Which one of the following is a correct mapping for the above ER diagram? Please tick the correct answer

□ E [A, B, C]

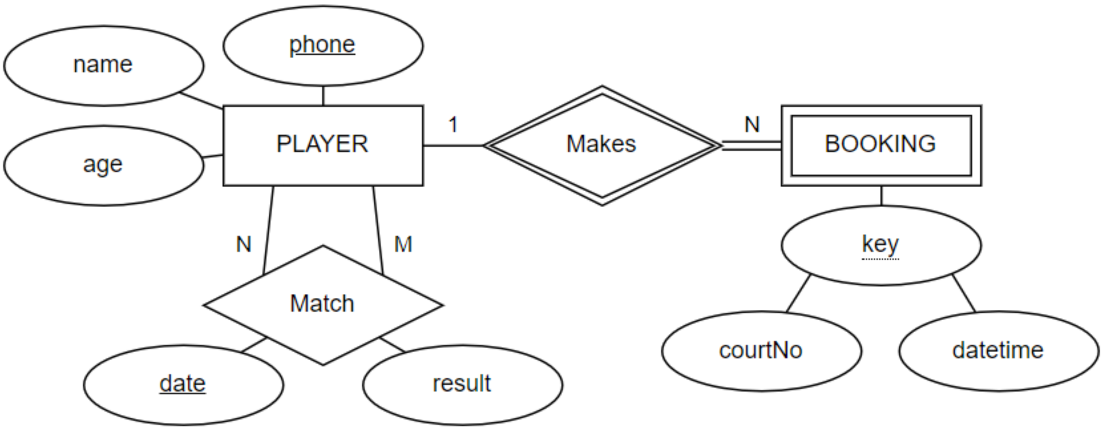
□ E [A, B]
C [A, C]
C.A references E.A

□ E [A, B]
C [A, C]
E.A references C.A

□ E [A, B]
C [A, C]
C.A references E.A

Question 5 **(8 marks)**

Consider the following ER diagram (the same as Question 1):



Map this ER diagram into a relational schema. Make sure to underline primary key attributes and specify all foreign keys like the example below.

T2(att1, att2, att3, att4)
T1.att4 references T.att4

Module 3 – Relational Query Languages - SQL (10 marks)

Question 6 **(3 marks)**

Consider the schema and set of function dependencies below:

R [a, b, c, d]

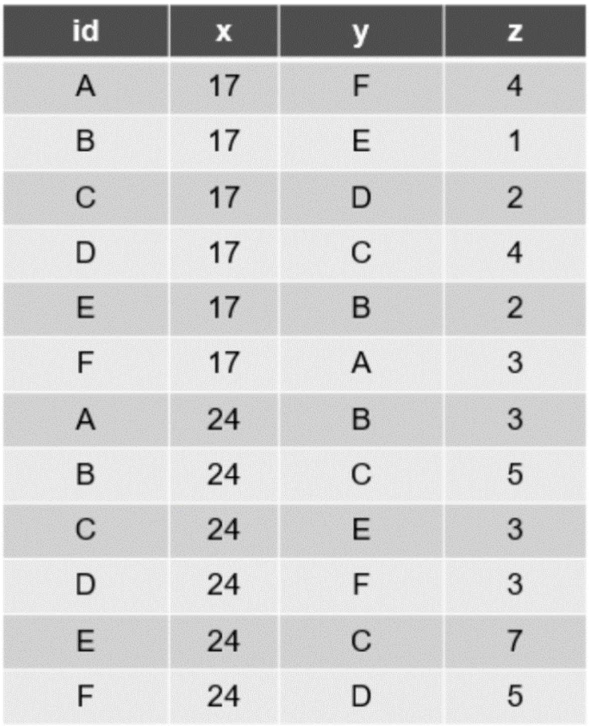
Where:

- a and c are integers,
- b and d are strings, and
- c must have a value recorded in every tuple.

Write an SQL DDL statement implementing this table.

Question 7 **(2 marks)**

Consider the following table with data for relation R and the SQL query below:



id	x	y	z
A	17	F	4
B	17	E	1
C	17	D	2
D	17	C	4
E	17	B	2
F	17	A	3
A	24	B	3
B	24	C	5
C	24	E	3
D	24	F	3
E	24	C	7
F	24	D	5

```
SELECT id, y
FROM   R
WHERE  (z <= 3 AND x = 24)
       OR (z <= 2 AND x = 17)
```

Select all of the following tuples that are in the result:

- □ (D, 17)
- □ (E, 17)
- □ (F, 17)
- □ (A, 24)
- □ (B, 24)
- □ (C, 24)

Question 8 **(5 marks)**

Consider the following schema:

> Staff [staffID, name]
> CorporateCard [accountID, staffID, cardLimit, balance]
> CorporateCard.staffID references Staff.staffID

Write an SQL DML statement that returns the name and account ID of all staff who have a balance that is greater than or equal to half their cardLimit.

A SQL syntax helper sheet is attached at the back of the exam paper.

(Explanatory note: a *corporate card* is an employer-issued credit card).

Module 4 – Database Design & Normalization (50 marks)

Questions 9 and 10 regard a database used to help tutors manage their teaching schedule. A sample of instance data is below:

ID	BuildingNumber	BuildingName	DayTime	TutorNumber	TutorName
10	7	Parnell	Thursday 12:00 PM	1345	Jelena
12	7	Parnell	Thursday 1:00 PM	1345	Jelena
13	47	Axon	Thursday 1:00 PM	4123	Alan
14	68	Chemistry	Friday 08:00 AM	2289	Riley
15	68	Chemistry	Friday 10:00 AM	4123	Alan
16	7	Parnell	Friday 08:00 PM	2289	Riley

The schema contains the following non-trivial functional dependencies:

{ID} → {BuildingNumber, BuildingName, DayTime, TutorNumber, TutorName}
{BuildingNumber} → {BuildingName}
{TutorNumber} → {TutorName}

Question 9 **(4 marks)**

Using the information above, provide a brief example and explanation of an operation that would cause a deletion anomaly. Your explanation should not exceed 50 words.

Operation:

Explanation:

Question 10 **(4 marks)**

What is the highest normal form of the tutor database schema given at the top of the page?

Questions 11 and 12 regard the relation R [A,B,C,D,E] with functional dependencies:

$C \rightarrow A$
$D \rightarrow E$
$E \rightarrow BC$
$AB \rightarrow D$

Question 11 **(4 marks)**

For the relation and functional dependencies above, write the attributes in the set closures listed below:

Set closures	**Answer**
i. C+	
ii. D+	
iii. AB+	
iv. AC+	

Question 12 **(4 marks)**

Consider the relation and functional dependencies at the top of the page. Write down all candidate keys for this relation and set of function dependencies:

Question 13 **(8 marks)**

Briefly explain why we would want to normalise a database.

Your explanation should:

- describe the desirable characteristics of a schema in 3NF and BCNF (4 marks), and
- explain what can happen to a database instance when its schema has not been normalised to 3NF or BCNF (4 marks).

Your answer should be brief and fit in the space provided.

Question 14 **(6 marks)**

Consider the following relation and functional dependencies:

R[A,B,C,D]
{A, B} → {C,D}
{A} → {C}

Normalise this schema to BCNF.

Question 15 **(5 marks)**

Consider the relation below with the given functional dependencies:

R [A, B, C, D, E, F, G, H, I]
{A} → {C, D, F}
{B} → {E}
{A, F} → {C, H}
{B, D, E} → {G, H}
{H} → {I}

Find a minimal cover for this relation and functional dependencies. Show your working using the three steps: RHS simplification, LHS simplification, and redundancy removal.

RHS simplification (1 mark)	**LHS simplification (1 mark)**	**Redundancy removal (1 mark)**
Minimal cover (2 marks):		

Question 16 **(10 marks)**

The minimal cover has been provided below for a given relation with a set of functional dependencies. Using the minimal cover, normalise the relation to 3NF such that all functional dependencies are preserved.

R [A, B, C, D, E, F, G, H]

{A} → {D, F}

{B} → {G, E}

{F, G} → {H}

Minimal Cover: { {A}→{D}, {B}→{G}, {B}→{E}, {A}→{F}, {F, G}→{H} }

Working:

Final result:

Question 17 **(5 marks)**

The following is a minimal cover for a relation R [A, B, C, D, E, F]:

AC → E
BD → A
A → B
E → CF

Which of the following is a 3NF synthesis for R? (There may be more than one.)

☐ R1[ACE], R2[ABD], R3[AB], R4[ACD]

☐ R1[ACE], R2[ABD], R3[AB], R4[CEF]

☐ R1[ACE], R2[ABD], R3[AB], R4[CEF], R5[ACD]

☐ R1[ACE], R2[ABD], R3[CEF], R4[ACD]

☐ R1[ACE], R2[ABD], R3[CEF], R4[ACD], R5[ADE]

Module 5 – Database Security (15 marks)

Question 18 (3 marks)

Consider the relational schema provided below, which is for a holiday touring company system:

Tour [id, date, description, location]

Attends [id, title, date, travelMethod]

Traveller [id, name, dob, phone, email, travelPartner]

Foreign Keys:

Attends.{title, date} references Tour.{title, date}

Attends.id references Traveller.id

Traveller.travelPartner references Traveller.id

The system administrator has created an account for Alex with the following requirements. Alex is the tour administrator and needs full access to the *Tour* and *Attends* tables. Alex should also have the ability to view the *Traveller* table.

Determine below what privileges need to be provided to Alex for each of the following relations (1 mark each).

Traveller:

Tour:

Attends:

Question 19 (3 marks)

Which of the following are NOT risks commonly associated with SQL injection?

- ☐ Attacker denies service to a particular user.
- ☐ Attacker disables the query optimiser component of the system.
- ☐ Attacker deletes tuple and drops tables of the associated database.
- ☐ Attacker upgrades the access level of their friends.
- ☐ Attacker identifies the username and password of other users.

Question 20 **(9 marks)**

Assume that there are 4 users: A1, A2, A3, A4. The DB admin issues the following SQL:

```
GRANT CREATETAB TO A1;
```

A1 creates two relations: **Employee** and **Department**, then gives the following privileges to A2:

```
GRANT SELECT ON Employee TO A2 WITH GRANT OPTIONS;
GRANT INSERT ON Department TO A2;
```

A2 then executes the following command:

```
GRANT SELECT ON Employee TO A3;
```

Based on this, answer the questions below.

a) Can the following be executed by user A2?

```
GRANT INSERT ON Department TO A4
```

Answer *yes* or *no*, and give a sentence explaining your answer. (3 marks)

b) Assume the following command is executed by A3:

```
GRANT SELECT ON Employee TO A4
```

If A1 then issues the command:

```
REVOKE SELECT ON Employee FROM A2
```

does A4 still have SELECT privilege on Employee? Answer *yes* or *no*, and give a sentence explaining your answer. (4 marks)

c) What type of Access Control is being used (select one option)? (2 marks)

☐ Discretionary ☐ Mandatory ☐ Role Based

END OF EXAMINATION

SQL syntax helper notes

DDL

```
CREATE TABLE <table name> (
 <column name> <column type> [<attribute constraint>]
 {, <column name> <column type> [<attribute constraint>]}
 [<table constraint> {, <table constraint>]
)
```

Table Constraints

```
[CONSTRAINT <constraint name>] PRIMARY KEY (<attribute name>
{, attribute name})

[CONSTRAINT <constraint name>] FOREIGN KEY (<attribute name> {,
attribute name}) REFERENCES <table name>(<attribute name> {,
attribute name}) [|ON DELETE SET NULL| SET DEFAULT|CASCADE]
[|ON UPDATE SET NULL| SET DEFAULT|CASCADE]
```

```
ALTER TABLE <table name>
 ADD <column name> <column type> [<attribute constraint>]
    {, <column name> <column type> [<attribute constraint>]}
  | DROP <column name> [CASCADE]
  | MODIFY <column name> <column options>
  | ADD <constraint name> <constraint options>
  | DROP <constraint name> [CASCADE]
```

DML

```
INSERT INTO <table name>
 [(<column name> {, <column name>}]
VALUES (<constant value> {, <constant value>}) | <select statement>

DELETE FROM <table name>
[WHERE <select condition>]

UPDATE <table name>
SET <column name> = <value expression>
 {, <column name> = <value expression>}
[WHERE <select condition>]
```

```
SELECT [DISTINCT] <attribute list> | <*>
FROM <table list>
[{<type of join> JOIN <table to join to>
ON <join attributes>}]
[WHERE <condition>]
[GROUP BY <grouping attributes>]
[HAVING <group condition>]
[ORDER BY column[ASC|DESC] {, column[ASC|DESC]}]
```

NOTATION

KEYWORD
<argument>
[optional]
{multiple}
| choice |

Complex Where Statements

```
LIKE “<string>” options: _ and %
IN (<list>)
IS [NOT] NULL
+, -, *, /
BETWEEN <value1> AND <value2>
```

Aggregation

```
COUNT([DISTINCT]<attribute
list>|*)
SUM([DISTINCT]<attribute list>|*)
AVG([DISTINCT]<attribute list>|*)
MAX([DISTINCT]<attribute list>|*)
MIN([DISTINCT]<attribute list>|*)
```

Joins

```
INNER JOIN | JOIN
OUTER JOIN
LEFT JOIN
RIGHT JOIN
```

Set Operations

```
SELECT …
{UNION [ALL]
SELECT …}
```

Nested Subqueries

```
exp [NOT] IN (<set>)
exp q {ANY|ALL} (<set>)
exp q (<single value>)
q = {>, <, =, <=, >=, <>}
```

Correlated Subqueries

```
SELECT …
FROM …
WHERE [NOT] EXISTS (subquery)
```

Views

```
CREATE VIEW <view name>
(<column name {, <column
name>}) AS
<select statement>

DROP VIEW [IF EXISTS]
<view name> {, <view name>}
[RESTRICT | CASCADE]
```