THE PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF MATHEMATICS & COMPUTER SCIENCE

FIRST SEMESTER EXAMINATIONS – 2023

THIRD YEAR COMPUTER SCIENCE

CS312 – DATABSE II

TIME ALLOWED: 3 HOURS

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1. Write your name and student number clearly on the front of the answer booklet.
2. There are Six (6) questions in the examination paper. Attempt all questions.
3. You have 10 minutes to read this paper. Please **do not** write during this time.
4. All answers must be written in the examination answer booklet.
5. Notes, calculators, mobile phones, textbooks and dictionaries are NOT allowed in this examination.
6. Use blue or black ink—not pencil or red ink.
7. **Do not write** anything or **turn this page** until you are told to do so.

Marking Scheme

Questions	**Marks**
Question 1	/10
Question 2	/12
Question 3	/8
Question 4	/12
Question 5	/24
Question 6	/14
Total	**/80**

Question 1 [2 + 2 + 2 + 2 + 2 = 10 marks]

a) Explain the concept of Logical Data Independence in relational data model.

b) Explain what referential integrity constraint is.

c) Why is it important to have constraints on database relations?

d) What are the properties of a schema key?

e) In your own words, explain what a functional dependency is.

Question 2 [6 + 6 = 12 marks]

Refer to the three relation instances given for the following questions.

r(N_1)

A	B	C	D
4	9	5	2
5	1	2	1
6	1	6	9
7	2	4	5
8	5	7	8

r(N_2)

A	B	C
5	1	2
7	4	6
8	5	7
4	6	8

r(N_3)

A	M	P	Q
4	2	4	2
7	3	2	1

a) Write the resulting relation for the following SQL statement based on the instance of relations given above.

```
SELECT * FROM N1 NATURAL JOIN N2 FULL OUTER JOIN N3 ON B=M;
```

b) Write the resulting relation for the following relational algebraic expression based on the instance of relations given above.

$$r(N1) \bowtie_{A=C} r(N1)*r(N2)$$

Question 3 [8 marks]

Consider the instance of the `FinalGrade` relation shown in the following table. It stores basic data for student's grades.

r(`FinalGrade`)=

CCode	StdId	Year	Semester	Level	Grade
CS201	01	2018	1	2	A
CS203	01	2018	1	2	B
CS207	01	2018	1	2	A
CS205	01	2018	1	2	C
LA204	01	2018	2	2	ω
LA204	01	2017	2	2	F
CS206	01	2018	2	2	ω
CS201	02	2018	1	2	A
CS203	02	2018	1	2	B
CS207	02	2018	1	2	A
CS205	02	2018	1	2	C
LA204	02	2018	2	2	ω
CS206	02	2017	2	2	F
CS206	02	2018	2	2	ω

For every set of attributes (that is, for every subset of `{CCode, StdId, Semester, Year, Level, Grade}` decide whether you can deduce the candidate keys from the given instance *r(FinalGrade)* given that *Null(FinalGrade, A)=N* for all attributes except *Null(FinalGrade, Grade)=Y*

where $A \in$ `{CCode, StdId, Year, Semester, Level}`,

N=''No'' and Y=''Yes''.

Assuming that the instance given is legal.

Question 4 [4 + 8 = 12 marks]

The following questions requires translating SQL statements to relational algebra based on the relation instances given in ***Appendix A***.

a)
```
SELECT * FROM Course,Grade WHERE OfferedToLevelOfStudy>3 AND
Points>10 AND Semester=1 AND YearOfStudy=2023;
```

b)
```
SELECT Course.CourseCode,Points,COUNT(*) FROM Student NATURAL JOIN
Grade ON Grade.StudentId=Student.StudentId RIGHT JOIN
       Course ON Course.CourseCode=Grade.CourseCode
        WHERE Points>0
GROUP BY Course.CourseCode,Points;
```

Question 5 [18 + 6 = 24 marks]

Below is a relation schema called `StudentGrade` that keeps record of student grades and a set of functional dependencies `F`.

```
StudentGrade={StudentId, CourseCode, YearOfStudy, Grade},
F={
    StudentId + CourseCode + YearOfStudy→Grade,
    StudentId + YearOfStudy→CourseCode,
    StudentId + YearOfStudy→ CourseCode + Grade
}
```

a) Compute a possible minimal cover of `F`.

b) Based on your answer in (a), determine if the schema `StudentGrade` is in 3NF.

Question 6 [6 + 8 = 14 marks]

The following questions are based on the relation instances given in ***Appendix A***.

a) Write an SQL query to compute the average of points for all the courses that each student has passed.

b) Write a cursor script in SQL to list the grades scored by each student. Your output of the cursor should contain the attributes `StudentId`, `FirstName`, `LastName`, `CourseCode`, `CourseName` and `Grade`. You are required to write your script in such a way that the output of cursor script will materialize as a single result set.

Appendix A

r(STUDENT)

StudentId	FirstName	LastName	Major
130120191	Dulcie	Masu	BSCS
230120191	Nania	AMORE	BSCS
430020190	Terrence	Kulapia	BSCS
430120191	Arason	Paul	BSCS
430120192	Dulcie	Sangin	BSCS
430220192	Julius	Tuckayo	BSCS
440020190	Veaolea	POKANA	BSCS
530020190	John	Babo	BSCS
530020191	Jaman	John	BSCS
530020192	Garry	Yasa	BSCS
630120131	Debbie	Saunbli	BSCS
630120134	Samantha	Maniat	BSCS
630120142	Maclachlan	LOS	BSCS
630120152	Lui	Sengi	BSCS
630120153	Leonarddon	Kombut	BSCS
630120172	Regina	Epli	BSCS
630120183	Ari	Tanao	BSCS
630120184	Wilfred	Wulbou	BSCS

r(COURSE)

CourseCode	CourseName	Points	OfferedToLevelOfStudy
BA131	Introduction to Business	3	2
CS101	Introduction to Computer Science I	16	1
CS102	Introduction to Computer Science II	16	1
CS103	Introduction to ICT I	12	1
CS104	Introduction to ICT II	12	1
CS105	Introduction to Programming I	12	1
CS106	Introduction to Programming II	12	1
CS201	Programming in Java	12	2
CS202	Object Oriented Programming	12	2
CS203	Operating System I	12	2
CS204	Database I	18	2
CS205	Networking I	12	2
CS206	Internet Programming I	12	2
CS207	Mathematics for Computer Science	12	2
CS208	Systems Analysis and Design	12	2
CS301	Algorithm Design & Implementation	11	3
CS308	Computer Hardware	11	3
CS401	Computer Science Project (A)	18	4

r(GRADE)

StudentId	CourseCode	YearOfStudy	Semester	Grade
130120191	CS204	2017	2	B
130120191	CS301	2018	1	B
230120191	CS201	2018	1	A
230120191	CS204	2018	2	A
430020190	CS204	2017	2	C
430020190	CS301	2018	1	C
430120191	CS204	2017	2	C
430120191	CS301	2018	1	C
430120192	CS204	2017	2	C
430120192	CS301	2018	1	C
430220192	CS204	2017	2	C
430220192	CS301	2018	1	C
440020190	CS201	2018	1	A
440020190	CS204	2018	2	A
530020190	CS204	2017	2	C
530020190	CS301	2018	1	C
530020191	CS204	2017	2	C
530020191	CS301	2018	1	C

Appendix B

- Given U, F, and $X, Y, Z, W \subseteq U$

1. (Reflexivity) $Y \subseteq X \vDash X \rightarrow Y$ (trivial FD)
2. (Augmentation) $X \rightarrow Y \wedge W \subseteq Z \vDash XZ \rightarrow YW$ (partial FD)
3. (Transitivity) $X \rightarrow Y \wedge Y \rightarrow Z \vDash X \rightarrow Z$ (transitive FD)
4. (Decomposition) $X \rightarrow YZ \vDash X \rightarrow Y \wedge X \rightarrow Z$
5. (Union) $X \rightarrow Y \wedge X \rightarrow Z \vDash X \rightarrow YZ$
6. (Pseudo transitivity) $X \rightarrow Y \wedge WY \rightarrow Z \vDash WX \rightarrow Z$

   (if $W = \varnothing$, pseudo transitivity turns into transitivity)

- Inference rules 1, 2 and 3 are known as **Armstrong's inference rules**