SPECIFY TYPE OF EXAMINATION	
FIRST ATTEMPT	☐
FIRST RESIT	☐
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RE-TAKE	☐

JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF INFORMATICS & INNOVATIVE SYSTEMS

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF COMPUTER SECURITY AND FORENSICS

2TH YEAR 2ND SEMESTER 2021/2022 ACADEMIC YEAR

MAIN CAMPUS

COURSE CODE: ICB 1203

COURSE TITLE: DATABASE ADMINISTRATION AND DESIGN

DATE: **10TH DECEMBER, 2022** **TIME: 9.00-12.00 NOON**

TIME: 2 HOURS

Instructions:

1. **This paper contains FIVE questions**
2. **Question one is compulsory**
3. **Answer any other two questions**

Registration No……

Question 1 (30 marks)

a) Differentiate between the following.
   i) Relational Model and the Entity-Relational Model. (2 marks)
   ii) Database schema and database instance. (2 marks)

b) Explain any two mechanisms that are used in concurrency control. (4 marks)

c) `fred` has two tables, `t1` and `t2` and issues the following privilege.

```
GRANT SELECT ON t1 TO amy;
```

In a session connected as `amy`, two UPDATEs are attempted and the following is observed.

```
SQL> UPDATE fred.t2 SET col1 = 0;
     UPDATE fred.t2 SET col1 = 0

     *
     ERROR at line 1:
     ORA-00942: table or view does not exist

SQL> UPDATE fred.t1 SET col1 = 0;
     UPDATE fred.t1 SET col1 = 0

     *
     ERROR at line 1:
     ORA-01031: insufficient privileges
```

Explain why two different error messages are given in these circumstances. (4 marks)

d) There are several forms of authorization (also called privileges) that may be assigned on parts of the database. Enumerate the four privileges that can be assigned to a user on data in the database. (4 marks)

e) Suppose you are given the following schema:

employee(emp_id, name, salary)
flights(flight_no, from, to, distance, depart_time, arrival_time)
aircraft(aircraft_id, manufacturer, model, range)
certified(emp_id, aircraft_id)

I. The certified relation indicates which employee(s) is/are certified to fly which aircraft. To find the names of employees who are certified to fly aircrafts manufactured by 'Boeing', the relational algebra expression is given as:

$$\prod_{name}\left(\sigma_{manufacturer='Boeing'}(aircraft \bowtie certified \bowtie employee)\right)$$

For each of the following queries, give an expression in the relational algebra.

i) Find the flight numbers of all the flights originating from Vancouver which depart after "13:00". (3 marks)

ii) Find the employee IDs of the pilots certified to fly aircraft manufactured by "Boeing". (3 marks)

II. The following SQL statement would be used to find the names of employees who are certified to fly aircraft manufactured by 'Boeing'.

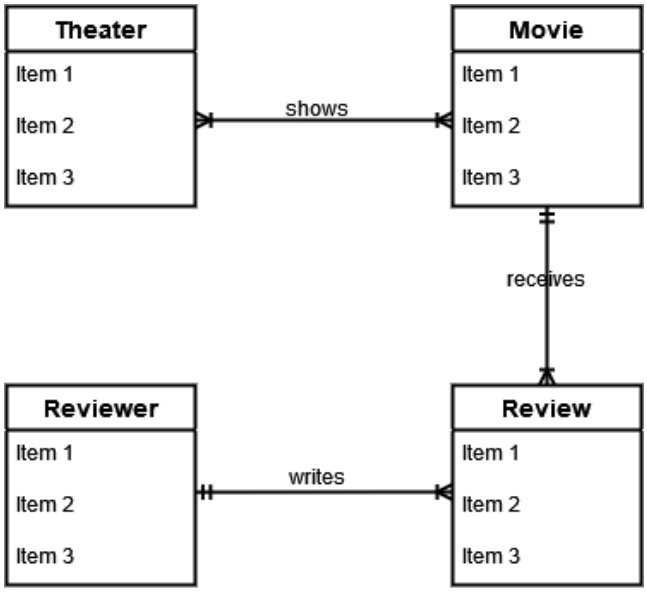
```
SELECT name
FROM aircraft, certified, employee
WHERE aircraft.aircraft_id = certified.aircraft_id
AND aircraft.manufacturer = 'Boeing' AND employee.emp_id = certified.emp_id
```

For each of the following, give the equivalent SQL statements.

i) Find the flight numbers of all the flights originating from Vancouver which depart after "13:00". (3 marks)

ii) Find the employee IDs of the pilots certified to fly aircraft manufactured by "Boeing". (3 marks)

f) Write the business rules that are reflected in the ERD shown below (4 marks)



Question 2 (20 marks)

a) Consider the following two relations

Table name: STUDENT
Primary key: STU_NUM
Foreign key: none

STU_NUM	STU_I_NAME	CLASS_CODE
321452	Bowser	10014
321452	Bowser	10018
321452	Bowser	10021
324257	Smithson	10014
324257	Smithson	10016

324257	Smithson	10021

Table name: CLASS
Primary key: CLASS_CODE
Foreign key: STU_NUM, CRS_CODE

CLASS_CODE	STU_NUM	CRS_CODE	CLASS_SECTION	CLASS_TIME	CLASS_ROOM	PROF_NUM
10014	321452	ACCT-211	3	TTh 2:30-3:45pm	BUS252	342
10014	324257	ACCT-211	3	TTh 2:30-3:45pm	BUS252	342
10018	321452	CIS-220	2	MWF 9:00-9:50am	KLR211	114
10018	324257	CIS-220	2	MWF 9:00-9:50am	KLR211	114
10021	321452	QM-261	1	MWF 8:00-8:50am	KLR200	114
10021	324257	QM-262	1	MWF 8:00-8:50am	KLR200	114

The tables indicate an implementation of the many-to-many (M:N) relationship between STUDENT and CLASS. However, in normal cases, this type of relationship is not supported directly in the relationship environment, and when it occurs, it leads to any redundancies and the relational operations become very complex and can lead to system efficiency errors and output errors.

i) What is the transformation rule for converting an M:N relationship between two relations to break the M:N relationship without loss of data. (3 marks)
ii) Convert the M:N relationship for the two relations above into two one-to-many (1:M) relationships with the intermediate relation named ENROLL. Indicate the primary keys and the foreign keys appropriately and fill all the records for each relation. (5 marks)

b) With a suitable example, differentiate between composite and multivalued attributes (4 marks)
c) Referential-integrity constraints involve exactly two relations. Consider a database that includes the following relations:

salaried-worker (name, office, phone, salary)
hourly-worker (name, hourly-wage)
address (name, street, city)

Suppose that we wish to require that every name that appears in address appear in either salaried-worker or hourly-worker, but not necessarily in both.

i) Propose a syntax for expressing such constraints. (2 marks)
ii) Discuss the actions that the system must take to enforce a constraint of this form. (2marks)

d) List the three design goals for relational databases and, in a single statement, explain why each is desirable (4 marks)

Question 3 (20 marks)

a) Explain the ACID properties and explain the usefulness of each. (8 marks)
b) SQL allows a foreign-key dependency to refer to the same relation, as in the following example:

create table *manager*
(employee-name ***char****(20),*
manager-name ***char****(20),*

primary key *employee-name,*
foreign key *(manager-name)* ***references*** *manager* ***on delete cascade*** *)*

Here, employee-name is a key to the table manager, meaning that each employee has at most one manager. The foreign-key clause requires that every manager also be an employee. Explain systematically exactly what happens when a tuple in the relation manager is deleted. (4 marks)

c) Consider the schema:

employee(employee-name, street, city)
works(employee-name, company-name, salary)
company(company-name, city)
manages(employee-name, manager-name)

Give an SQL DDL definition for the tables of this database. Identify referential-integrity constraints that should hold and include them in the DDL definition. (8 marks)

Question 4 (20 marks)

a) Explain the distinctions among the terms primary key, candidate key, and superkey (3 marks).

b) A university registrar's office maintains data about the following entities:

- courses, including number, title, credits, syllabus, and prerequisites;
- course offerings, including course number, year, semester, section number, instructor(s), timings, and classroom;
- students, including student-id, name, and program; and
- instructors, including identification number, name, department, and title.

Further, the enrollment of students in courses and grades awarded to students in each course they are enrolled for must be appropriately modeled.

i) Construct an E-R diagram for the registrar's office (8 marks)
ii) Document all assumptions that you make about the mapping constraints. (3 marks)

e) Let $R = (A, B, C)$ and r_1 and r_2 both be relations on schema R. If there are 200 tuples in r_1 and 350 tuples in r_2, give the minimum and maximum sizes (in tuples) of the resulting relation produced by the following expressions.

i) $r_1 \cup r_2$ (2 marks)
ii) $r_1 \cap r_2$ (2 marks)
iii) $r_1 \times r_2$ (2 marks)

Question 5 (20 marks)

a) Suppose you are given the following information about a database for a chain of drug stores:

– A drugstore sells drugs prescribed by doctors to patients,
– Each drugstore in the chain is identified by a store name, address, and a phone number,

- Patients are identified by a patient ID, and their names, addresses, and ages must be recorded,
- Doctors are identified by a doctor ID. Each doctor's name, specialty, and years of experience must be recorded,
- Each drug is made by a pharmaceutical company and sold to the drugstore. The drug's trade name identifies the drug uniquely from among the products of that company. For each drug, the trade name and formula must be recorded
- Each pharmaceutical company is identified by name and has a phone number, every patient has a primary doctor,
- Every doctor has at least one patient,
- Each drugstore sells several drugs and has a price for each. A drug could be sold at several drugstores, and the price could vary from one drugstore to another,
- Doctors prescribe drugs for patients. A doctor could prescribe one or more drugs for several patients, and a patient could obtain prescriptions from several doctors,
- Each prescription has a date and a quantity associated with it. You can assume that if a doctor prescribes the same drug for the same patient more than once, only the last such prescription needs to be stored,
- Pharmaceutical companies have long-term contracts with drugstores. A pharmaceutical company can contract with several drugstores, and a drugstore can contract with several pharmaceutical companies. For each contract, you have to store a start date, an end date, and the text of the contract,
- Drugstores appoint a supervisor for each contract. There must always be a supervisor for each contract, but the contract supervisor can change over the lifetime of the contract,
- If a pharmaceutical company is deleted, you need not keep track of its products any longer.

Perform the following.

i) Identify the entities in this scenario. (4 marks)

ii) Define the relational schema corresponding to the entity sets and relationship sets. Underline the primary keys, and the foreign keys. (8 marks)

b) Explain the difference between physical and logical data independence (4 marks)

c) List two reasons why we may choose to design a view (2 marks).

d) Enumerate any two disadvantages of database systems (2 marks)