The Open University of Sri Lanka
Faculty of Natural Sciences
B.Sc. Degree Programme

532

Department	: Computer Science
Level	: 3/4
Name of the Examination	: Final Examination
Course Title and Code	: CSU3301 - Database Design and Implementation CSU4315/CPU2241 - Database Management Systems
Academic Year	: 2023/2024
Date	: 19.03.2024
Time	: 09.30 am – 11.30 am
Duration	: 02 Hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **SIX (06)** questions in six (06) pages. Each question has sub questions.
3. Answer **FOUR (04)** questions ONLY.
4. Answers for each question should commence from a new page.
5. Draw clear diagrams where necessary.
6. Involvement in any activity that is considered as exam offense will lead to punishment.
7. Use blue or black ink to answer the questions.
8. Clearly state your index number in your answer script.

QUESTION 01

1) What is the role of a *Database Management System* (DBMS)? Briefly describe mentioning two points.
2) Define *metadata* in the context of databases.
3) What challenges arise from *data redundancy* in file systems? Write two reasons.
4) Briefly explain the following terms in the context of database systems.
   a) Primary Key
   b) Derived Attribute
   c) Foreign Key
   d) Multivalued Attribute
5) State whether the following statements are true or false. If only a statement is false, justify your answer.
   a) In the hierarchical model, a child record can have only one parent.
   b) Composite attributes cannot be further subdivided to yield additional attributes.
   c) In a recursive relationship, a relationship can exist between occurrences of the same entity set.
   d) In a set in the network database model, a member record can have only one owner.
6) By means of examples explain the terms *Total Participation* and *Cardinality.*
   "*A doctor may treat patients. Maximum number of patients treated by a doctor is six. A patient must be treated by one and only one doctor*"
   Using the Chen notation draw the Entity Relationship Diagram for this description. Show the Connectivity, Cardinality and Participation of the relationships.

QUESTION 02

1) A company structure requires a comprehensive database to manage its operations effectively. The organization is composed of various departments, projects, suppliers, employees, and their respective children. Here is the information that should be captured within the database:

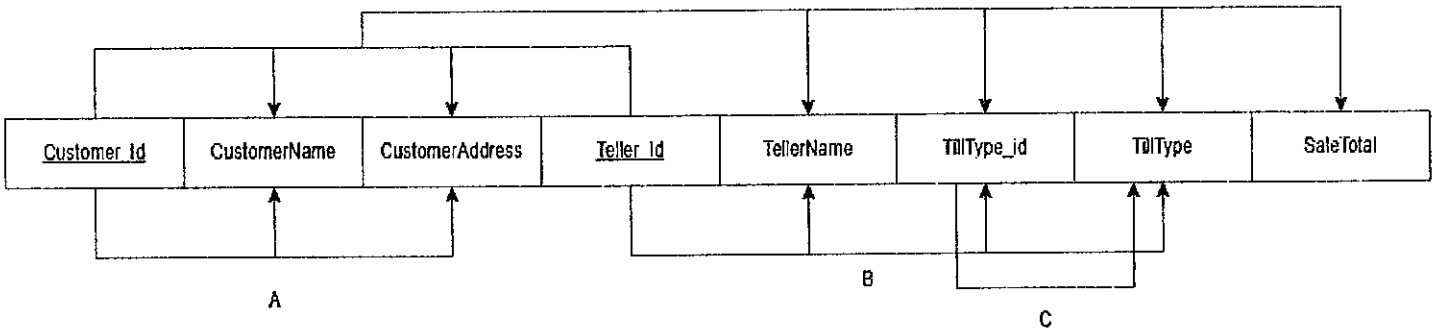
   - Each department has a unique name, may have multiple phone numbers, and is managed by an employee. The start date of the department manager is recorded.
   - Departments oversee various projects, each with its own name and due date. Projects can have identical names but must be in different locations.
   - Suppliers provide specific parts for projects, with the price of each part being recorded for every project they supply.
   - Parts are identified by a number and have a name.
   - Suppliers are identified by IDs, names, and specialties.
   - Employee data include a social security number, name, address (detailing city, street, and building), salary, and date of birth.
   - An employee works for one department but may be involved in several projects, with the hours worked per week recorded for each project.
   - The direct supervisor for each employee is tracked.
   - Employees may have several children, with the name, sex, age, and relationship to the employee recorded for each child.

a) Identify all entities required for the company database as per the details provided.
b) Determine appropriate attributes for each identified entity and assign a primary key where applicable.
c) Discuss the presence of any recursive relationships within the company structure and provide justification for your answer.
d) Evaluate the information to identify if any weak entities exist in the proposed database design and justify your reasoning.
e) Conceptualize and draft an ER diagram that captures all entities, their relationships, and attributes. Clearly outline any assumptions that support your design choices.

Note: Make assumptions, if only necessary, when answering the above questions. State them clearly.

QUESTION 03

1) What is *Normalization* in DBMS?
2) Consider the following diagram.

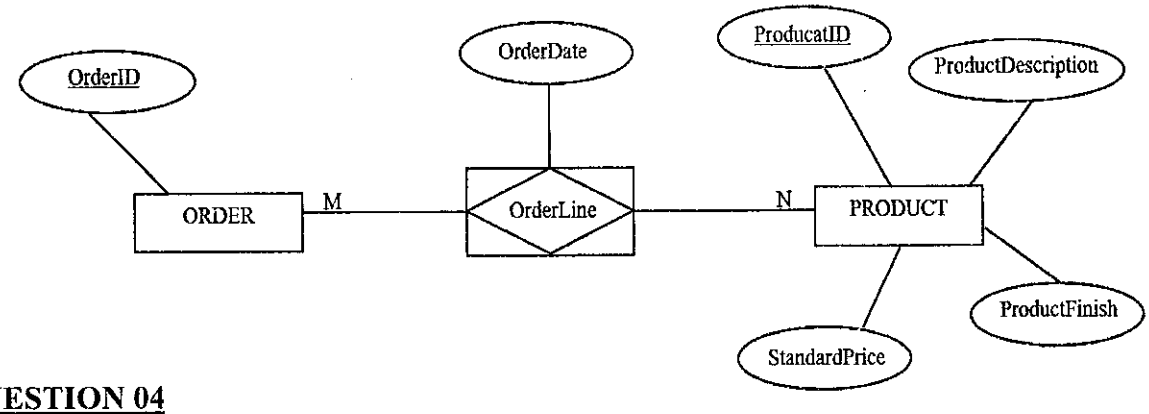


a) What is the Normal form that this table is currently in?
b) What is *Partial Dependency*? If there are any partial dependencies in the above diagram, identify and mark them.
c) What is *Transitive Dependency*? If there are any transitive dependencies in the above diagram, identify and mark them.
d) Normalize this table to conform - Third-Normal Form (3NF).
e) Clearly show the steps (1NF, 2NF, 3NF) you follow and mark the primary keys.
f) What is the main requirement for a table to be in the *Boyce Codd Normal Form* (BCNF)? Are the tables you acquire in part d) also in BCNF?

3) Fill in the blanks with suitable words,

a) Relationships in an E-R diagram is represented by ..... symbols.
b) ..... occur when adding new data to a file system requires adding unrelated data, leading to inefficiency and data integrity issues.
c) The components of the Entity-Relationship (E-R) model include ....., ..., and Relationships.
d) ..... participation is indicated by a circle at the edge of an entity in an ER Diagram.
e) A ..... represents the absence of data entry, and it is not permitted in the primary key column to maintain entity integrity.

4) Draw the appropriate *Relational Schema* for the following ER diagram.



QUESTION 04

1) Suppose you have accepted a project to create a database for the 'Arogya' pharmacy chain, which has offered a free lifetime supply of medicine as compensation. The following details have been gathered for the initiation of the database design:

- Patients are uniquely identified by a PSSN, along with their names, addresses, and ages which need to be recorded.
- Doctors have a unique identifier known as a DSSN, and their names, specialties, and years of experience must be captured.
- Every pharmaceutical company is distinguished by its name and it must have a phone number listed.
- Drugs are characterized by their trade name and formula, with the trade name being unique within the scope of its pharmaceutical company.
- The removal of a pharmaceutical company from the database means its drugs are no longer tracked.
- Each pharmacy under the 'Arogya' brand has an identifiable name, address, and phone number.
- Each patient is linked to a primary physician, and every doctor is associated with at least one patient.
- Pharmacies offer an array of drugs, each with a specific price that may differ from pharmacy to pharmacy.
- Doctors issue drug prescriptions to patients, noting the date and the quantity for each.
- Only the latest prescription of the same drug from the same doctor for the same patient is retained.
- There are contracts between pharmaceutical companies and pharmacies which include the start date, end date, and the contract's content.
- Each contract is overseen by a supervisor, a role that may change throughout the contract's term.

Note: Make assumptions, if only necessary, when answering the following questions. State them clearly.

a) Identify all entities necessary for representation in the 'Arogya' pharmacy database.
b) Determine the appropriate attributes for each entity and designate a primary key. Also, identify one composite attribute.
c) Review the provided information to determine if there are any weak entities and justify your selection.

d) Develop an ER diagram that outlines the entities, their interconnections, and attributes. Clearly articulate any assumptions you've made during the design process.

e) Discuss the necessary alterations to your design if each drug must have a uniform price across all 'Arogya' pharmacies.

f) Explain how you would modify the design to store multiple prescriptions for the same drug prescribed by the same doctor to the same patient.

2) Consider the following database instances.

Table: STUDENT

Student_ID	Student_Name	Age	Gender	Course_ID
401	Sandun	22	Male	101
402	Nadeesha	20	Female	102
403	Ruwan	23	Male	103
404	Malsha	21	Female	102
405	Tharusha	24	Male	101

Table: COURSE

Course_ID	Course_Name	Instructor	Credits
101	Mathematics	Dr. Fernando	3
102	Physics	Prof. Mendis	4
103	Chemistry	Dr. Silva	3
104	Biology	Prof. Perera	3

Write suitable SQL queries to do the following tasks.

a) Retrieve the names of male students.

b) Get the names of courses with more than 3 credits.

c) Retrieve the names of students who are enrolled in courses taught by Prof. Mendis.

d) Retrieve the name(s) of student(s) who are enrolled in the Mathematics course and are aged below 23.

QUESTION 05

Explore the following database instances tailored for managing Sri Lanka's vibrant tourism sector:

Table: HOTEL

Hotel_ID	Hotel_Name	Location	Stars
H101	Lagoon Paradise	Negombo	5
H102	Mountain View	Kandy	4
H103	Beachside Bliss	Hikkaduwa	4
H104	Ancient Gateway	Anuradhapura	3

Table: ACTIVITY

Activity_ID	Activity_Name	Location	Cost (LKR)
A201	Whale Watching	Mirissa	6000
A202	Cultural Tour	Kandy	1500
A203	Surfing Lessons	Arugam Bay	2500
A204	Safari	Yala	8000

Table: VISITOR

Visitor_ID	Visitor_Name	Country
V301	Alice	UK
V302	Bob	Australia
V303	Chen	China
V304	Devi	India

Table: BOOKING

Visitor_ID	Hotel_ID
V301	H101
V302	H102
V303	H103
V304	H104
V301	H102
V302	H103

Table: ATTRACTION

Attraction_ID	Attraction_Name	Location	Hotel_ID
AT401	Fort Frederick	Trincomalee	H104
AT402	Temple of the Tooth	Kandy	H102
AT403	Ramboda Falls	Nuwara Eliya	H102
AT404	Galle Fort	Galle	H103

1) What are the output tables you get when you apply the following relational database operators to the above tables (HOTEL, ACTIVITY, VISITOR, BOOKING and ATTRACTION are table names)?
   a) HOTEL **DIVIDE** BOOKING:
   b) VISITOR **DIFFERENCE** BOOKING:
   c) ACTIVITY **INTERSECT** ATTRACTION:
   d) ATTRACTION **PRODUCT** VISITOR:

2) Write suitable SQL queries to perform the following tasks:
   a) Select the Hotel_Name and the character length of the Hotel_Name from the HOTEL table.
   b) Identify visitors whose names start with the letter "A."
   c) Retrieve the names of visitors from 'India'.
   d) Find the hotel close to 'Temple of the Tooth' attraction.
   e) Calculate the total number of records in the ATTRACTION table.

3) Design a database for the Sri Lankan Census Department to manage and store census data, including historical and future records. The database must adhere to the following specifications:
   - A census is conducted every 10 years, with each census year being unique. Information recorded includes notes, the total population of Sri Lanka, and data for each province.
   - Each province is identified by a unique name and has a recorded square area value. Provinces provide their population counts for each census.
   - Every person is identified by a unique ID number (Id_no), along with their name and birthday. Individuals report their age in each census.
   - Addresses are uniquely identified and include street name, city, and district. Each person is associated with exactly one address.

   a) Draw an ER diagram for this database. State all assumptions you make.
   b) Translate your ER diagram into a relational schema.

QUESTION 6

1) Explain the difference between GROUP BY and ORDER BY clauses in SQL.
2) Describe the function of the JOIN operation in SQL.
3) Consider the following database instances.

Table: FARMER

FarmerID	Name	District
F001	Nimal	Kandy
F002	Sunil	Galle
F003	Kamal	Matale
F004	Priyantha	Hambantota

Table: CROP

CropID	CropName	Season
C101	Tea	First
C102	Rubber	Second
C103	Cinnamon	First
C104	Coconut	All

Table: PRODUCTION

FarmerID	CropID	HarvestedAmount	Year
F001	C101	1500	2023
F002	C103	600	2023
F003	C102	1100	2023
F004	C104	2000	2023

Write suitable SQL queries to do the following tasks

a) Find the total harvested amount for each crop in the year 2023.
b) Determine the number of distinct crops each farmer produces.
c) Calculate the average harvested amount for crops in the "Second" season.
d) Identify the crop with the maximum harvested amount in 2023.
e) List full details of crops that are harvested all year round.
f) Retrieve farmer IDs for those who do not grow "Tea." Arrange the output in ascending order.

4) Consider a small hospital system.

- The Hospital has wards, doctors and patients. Each ward has an ID to identify it. Apart from that, it keeps the ward name.
- Each doctor has an ID to identify them. Apart from that, they keep the name and phone number. Each doctor works on at least one ward and each ward is worked by at least one doctor.
- Each patient has an ID to identify them. Apart from that, they keep the name and address. Each doctor treats at least one patient and each patient is treated by at least one doctor.
- Each patient may admit to a ward and each ward is admitted by at least one patient.

a) Draw the complete ER diagram for the above given scenario. Use Chen notation.

- Show the proper Connectivity of the Relationships.
- Show the Cardinality of each Entity with each Relationship.
- Represent the Relationship's Participation as Optional or Mandatory.