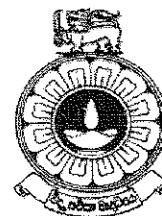


The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering



Study Programme	:	Bachelor of Science Honours in Engineering Bachelor of Software Engineering Honours
Name of the Examination	:	Final Examination
Course Code and Title	:	EEX4366/EEI4366 - Data Modelling and Database Systems
Academic Year	:	2024/25
Date	:	23 rd February 2026
Time	:	0930-1230h
Duration	:	3 hours

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Four (4)** questions in **Four (4)** pages.
3. Answer **all** questions.
4. Answer for each question should commence from a new page.
5. This is a Closed Book Test (CBT).

Question 01

Answer the following questions based on the following courier delivery management system scenario.

Entities and Attributes

- Customer (CustomerID, FullName, NIC, ContactNumber, Address)
 - NIC is unique.
- Parcel (ParcelID, Weight, ParcelType, DeclaredValue)
- DeliveryVehicle (VehicleID, VehicleNumber, VehicleType, Capacity)
- Driver (DriverID, Name, LicenseNumber, ContactNumber)
- DeliveryOrder (OrderID, PickupDate, EstimatedDeliveryDate, DeliveryStatus)
- Location (LocationID, Address, City, PostalCode)

Business Rules

1. A customer can send many parcels, but each parcel belongs to exactly one customer.
2. Each delivery order may include multiple parcels, but each parcel is assigned to only one delivery order.
3. Each delivery order is handled using exactly one delivery vehicle, while a vehicle can handle many delivery orders.
4. Drivers may be assigned to multiple vehicles over time, and vehicles may be assigned to different drivers over time. The assignment period (StartDate, EndDate) must be recorded for each assignment.

- a. Create an Enhanced Entity Relationship Diagram (EERD) for the above scenario. Clearly illustrate all entities, attributes, primary keys, relationships, participation constraints, and cardinalities. (12 marks)
- b. Enhance the diagram created in Part (A) by incorporating the following additional requirements. Indicate all enhancements clearly in the same diagram. (03 marks)
- Create specialization for DeliveryVehicle into the following subtypes:
- Truck → Attribute: LoadLimit
 - Van → Attribute: RefrigerationSupport (Boolean)
 - Bike → Attribute: MaxDistance
- Assume the specialization is **Disjoint and Total**.
- c. Introduce a new entity: DeliveryAssistant (AssistantID, Name, ContactNumber) (06 marks)
- A delivery assistant may assist multiple delivery orders, and each delivery order must have at least one delivery assistant.
- d. Create an entity: DeliveryHistory (HistoryID, ActualDeliveryDate, DeliveryRemarks, ReceiverName, ReceiverSignatureStatus). Each DeliveryHistory record must be associated with: (06 marks)
- One DeliveryOrder
 - One Driver
- A delivery order may have multiple historical records.
- e. Apply a domain constraint to DeliveryStatus so that it allows only: (03 marks)
- Pending
 - In Transit
 - Delivered
 - Cancelled

Question 02

Consider the following relational database schema for a university examination management system.

```
CREATE TABLE Student ( StudentID INT PRIMARY KEY, FullName VARCHAR(200) NOT NULL, Email VARCHAR(150) UNIQUE );
```

```
CREATE TABLE Course ( CourseID INT PRIMARY KEY, CourseName VARCHAR(200) NOT NULL, Level VARCHAR(50) CHECK (Level IN ('Foundation', 'Diploma', 'Degree')));
```

```
CREATE TABLE Enrollment ( EnrollmentID INT PRIMARY KEY, StudentID INT NOT NULL, CourseID INT NOT NULL, EnrollmentDate DATE NOT NULL, FOREIGN KEY (StudentID)
```

REFERENCES Student(StudentID), FOREIGN KEY (CourseID) REFERENCES Course(CourseID),
 UNIQUE(StudentID, CourseID));

CREATE TABLE Exam (ExamID INT PRIMARY KEY, ExamDate DATE NOT NULL, CourseID INT
 NOT NULL, FOREIGN KEY (CourseID) REFERENCES Course(CourseID));

CREATE TABLE QuestionPaper (PaperID INT PRIMARY KEY, ExamID INT NOT NULL,
 TotalMarks INT NOT NULL, FOREIGN KEY (ExamID) REFERENCES Exam(ExamID));

CREATE TABLE ExamRegistration (RegistrationID INT PRIMARY KEY, StudentID INT NOT
 NULL, ExamID INT NOT NULL, RegistrationDate DATE NOT NULL, ExamStatus VARCHAR(50)
 NOT NULL CHECK (ExamStatus IN ('Registered', 'Completed', 'Absent', 'Cancelled')), FOREIGN
 KEY (StudentID) REFERENCES Student(StudentID), FOREIGN KEY (ExamID) REFERENCES
 Exam(ExamID), UNIQUE(StudentID, ExamID));

Assumptions

1. A student must be enrolled in the relevant course before registering for its exam.
2. Each exam belongs to exactly one course.
3. ExamStatus values are restricted to:
 - Registered
 - Completed
 - Absent
 - Cancelled
4. Course Level values are restricted to:
 - Foundation
 - Diploma
 - Degree

Write SQL queries for the following:

- a. Retrieve the **StudentID** and **FullName** of students who have (06 marks)
 registered for examinations belonging to **more than one distinct
 course**.
- b. Retrieve the **CourseID**, **CourseName**, and total number of (08 marks)
distinct students who have registered for exams of that course.
 Display **all courses** that have the **highest number of registered
 students**
- c. List the **ExamID** and **ExamDate** of exams for which **all** (04 marks)
registered students have an ExamStatus of '**Completed**'.
 (Consider only exams that have at least one registered student.)
- d. Calculate the total number of exam registrations grouped by (08 marks)
Course Level.
 (The Course Level must be obtained through the relationship
 between ExamRegistration, Exam, and Course.)
- e. Retrieve the **StudentID**, **FullName**, and **Email** of students who (04 marks)
 have **not registered for any examination**.

Question 03

- a. Define **Boyce-Codd Normal Form (BCNF)** and compare it with Third Normal Form (3NF). Use a small example schema to show a relation that is in 3NF but not in BCNF, and explain why. (03 marks)
- b. Describe **XML** and its role in web applications. Differentiate between **structured data** and **semistructured data**. (03 marks)
- c. The Enhanced ER (EER) model includes ideas from object-oriented design. Explain the difference between the following pairs of concepts, using examples: (06 marks)
 - i. Overlapping and Disjoint constraints in specialization/generalization.
 - ii. Total and Partial completeness constraints in specialization/generalization.
- d. Answer the following about how a DBMS handles data storage: (08 marks)
 - i. Give **two main reasons** why a DBMS manages its own data files and memory, instead of letting the Operating System handle everything.
 - ii. Name **three specific features** a DBMS needs for its memory management that a standard OS file system does not provide.

Question 04

- a. What is RAID, and why is it used in database systems? (05 marks)
Compare RAID Level 1 (Mirroring) and RAID Level 5 (Distributed Parity) by discussing their:
 - i. Approach to redundancy (data protection).
 - ii. Read and write performance.
- b. What is the purpose of **database triggers**, and how do they differ from **stored procedures**? Provide a simple example of a trigger in SQL. (05 marks)
- c. What is a **FLWOR expression** in XQuery? Explain the role of each clause: **FOR, LET, WHERE, ORDER BY, RETURN**. (05 marks)
- d. What is a functional dependency in a database table? Explain with a clear example. How does understanding functional dependencies help us define the Second Normal Form (2NF)? (05 marks)

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