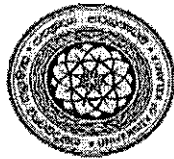


Student No:



University of Kelaniya – Sri Lanka
Centre for Distance & Continuing Education
Bachelor of Science (General) External
Second Year Second Semester Examination - 2023
Faculty of Science
COSC 27583 - Database Management Systems

11th of July 2026

No. of Questions: Four (04)

No. of Pages: Four (04)

Time: Two (02) Hours

Answer all questions

1.

(a)

(i) State three (03) types of database models.

(6 Marks)

(ii) Define the following terms:

A. Mini-World

B. Database

C. Database Management System

(12 Marks)

(iii) Briefly explain four (04) functionalities of a typical Database Management System.

(12 Marks)

(b)

(i) Define “*Program-Data Independence*” in the database approach and illustrate it with a suitable example.

(10 Marks)

(ii) What is the main difference between “*Casual Users*” and “*Naïve (Parametric) Users*” of databases?

(8 Marks)

(iii) Briefly explain four (04) situations where a traditional Database Management System (DBMS) may not be sufficient

(12 Marks)

(c)

(i) Compare and contrast “*Database Schema*” and “*Database State*”.

(12 Marks)

(ii) Briefly explain the three (03) levels of the Three-Level Database Design Architecture.

(12 Marks)

(iii) Compare “*Centralized DBMS Architecture*” and the “*Client-Server Architecture*”.

(16 Marks)

2. The hospital database stores information about departments, doctors, patients, medical programs, and the treatment sessions received by patients.

Consider the following requirements.

- The hospital has one or more **departments**. Each department has a department ID, department name, and location.
- A **doctor** belongs to exactly one department, and each department has one or more doctors assigned to it. Each doctor has a doctor ID, name, specialization, and one or more contact numbers (e.g., office number, personal number).
- A doctor may supervise other doctors, but each doctor is supervised by at most one doctor.
- The hospital offers one or more **medical programs**. Each medical program has a program ID, program name, commencement year, and total number of treatment sessions required.
- Medical programs are categorized as **Inpatient Programs** and **Outpatient Programs**. Inpatient_Programs has bed_capacity and Outpatient_Programs has clinic_day.
- A **patient** registers under exactly one medical program. Each patient has a patient ID, Name (given name and surname), date of birth, age, one emergency contact telephone number, gender, and registration year.
- A patient receives one or more **treatment sessions**. A treatment session is identified only within a patient and has a session number, treatment date, and outcome.
- Each treatment session is supervised by exactly one doctor.
- For every doctor assigned to a medical program, record the assignment date and the doctor's role in the program.
- A medical program may have many doctors assigned to it, and a doctor may be assigned to many medical programs.

Considering the above description, answer the following questions.

- Identify the entities that could be used for the above requirements.
(10 Marks)
- Identify suitable attributes and the primary keys for each of the entities, and for each of the entities that you have identified, list the multi-valued, composite, and derived attributes, if any.
(30 Marks)
- Is/Are there any weak entity/entities? If so, give the identifying owner/owners.
(10 Marks)
- Is there any superclass/subclass relationship from this description? Justify your answer.
(5 Marks)
- Draw a suitable EER (Enhanced Entity Relationship) diagram for the Hospital database. State any assumptions that you make.
(45 Marks)

3.

- (a) The following table contains sample data of books and publishers at **XYZ Bookshop**.

Book_ID	Title	Publisher_Name	Press_Location	Selling_Price
B001	Database Systems	TechBooks	Colombo	4500
		LearnPub	Gampaha	4300
B002	Data Structures	TechBooks	Colombo	3900
		SmartPress	Kandy	4100
		LearnPub	Gampaha	4000

- (i) Convert this table to a relation (named **BOOK_PUBLISHER**) which is in **First Normal Form (1NF)**. (10 Marks)
- (ii) Draw a relational schema for **BOOK_PUBLISHER** and show the functional dependencies. (10 Marks)
- (iii) Identify a candidate key for the above relation. (10 Marks)
- (b) Consider the following relation **REGISTRATION** and functional dependencies FD1, FD2, FD3, and FD4.

REGISTRATION (StudentID, StudentName, StudentAddress, CourseID, CourseName, CourseFee, RegistrationDate, ScholarshipAmount)

FD1: StudentID $\rightarrow$ StudentName, StudentAddress

FD2: CourseID $\rightarrow$ CourseName, CourseFee

FD3: StudentID, CourseID $\rightarrow$ RegistrationDate

FD4: CourseFee $\rightarrow$ ScholarshipAmount

- (i) Draw the functional dependency diagram. (10 Marks)
- (ii) Identify the primary key for the given relation. (10 Marks)
- (iii) Briefly explain the insertion anomaly and modification anomaly using suitable examples for the relation **REGISTRATION**. (10 Marks)
- (iv) Assume that the relation has a row
< S015, 'K. Silva', 'Negombo', 'C010', 'Artificial Intelligence', 75000.00, '12-MAR-25', 75000.00 >
If the student withdraws from the course and this row is deleted from the table, what is the possible anomaly that can occur? Give reasons. (10 Marks)
- (v) What is the current normal form of the **REGISTRATION** relation? Justify your answer. (10 Marks)
- (vi) Decompose the **REGISTRATION** relation into the highest normal form that it can achieve. State the reason behind each decomposition. (10 Marks)
- (vii) Clearly indicate the primary key(s) and foreign key(s) in each relation. (10 Marks)

4.

- (a) Consider the following database instance and give the output for the given relational algebra expressions.

Employee

Eid	EName	Department
E101	John	HR
E102	Mary	IT
E103	David	Finance
E104	Anne	IT

Project

Pid	Project_Name
P1	Payroll
P2	Website
P3	Inventory
P4	Analytics

Work_On

Eid	Pid
E101	P1
E102	P2
E102	P3
E103	P1
E105	P5

Give the output for the following relational algebra expressions.

- (i) $\Pi_{Department}(Employee)$ (10 Marks)
- (ii) $\Pi_{EName}(\sigma_{Department='IT'}(Employee))$ (10 Marks)
- (iii) $\Pi_{Pid}(Project) - \Pi_{Pid}(Works_On)$ (10 Marks)
- (iv) $Employee \bowtie Works_On$ (10 Marks)
- (v) $\Pi_{Project_Name}(\sigma_{Eid='E102'}(Works_On) \bowtie Project)$ (10 Marks)

- (b) Consider the following relations of an online shopping system.

CUSTOMER (Customer_ID, Customer_Name, City)

PRODUCT (Product_ID, Product_Name, Price)

PURCHASE (Customer_ID, Product_ID, Purchase_Date)

Express the following queries using relational algebra.

- (i) Get the list of all cities where customers live. (10 Marks)
- (ii) Find the names of products purchased by customer 'Kasun Silva'. (10 Marks)
- (iii) Find the names of customers who purchased a product on '2026-06-20'. (10 Marks)
- (iv) Find the names of products that have never been purchased. (10 Marks)
- (v) Find the names of customers who have not purchased any products. (10 Marks)

***** End of the Paper *****