INTERNATIONAL UNIVERSITY OF EAST AFRICA
'Learning to Succeed'

FACULTY OF SCIENCE AND TECHNOLOGY

END OF SEMESTER EXAMINATIONS - DECEMBER 2025

PROGRAMME: MIT
YEAR/SEM: YEAR 1/SEMESTER 1
COURSE CODE: MIT714
NAME: DATABASE SYSTEMS DEVELOPMENT

DATE:
TIME:

INSTRUCTIONS TO CANDIDATES:

SECTION A

Section A is Compulsory

Question 1:

QUESTION ONE (40 MARKS)

i. Define the term Database Management Systems **(02 Marks**)

ii. At Gulu Regional Referral Hospital, patient files have recently been digitized into a centralized DBMS. Explain how the DBMS improves day-to-day hospital operations. **(02 marks)**

iii. The International University of East Africa is replacing departmental standalone systems with a centralized university-wide DBMS. Explain two benefits the university will achieve. **(02 marks)**

iv. During a system audit at Kampala City Water Utility, the auditors request that you explain what is currently "running in memory" as the active database. Using this context, define the term Database Instance. **(02 marks)**

v. The ICT Directorate of Jinja City Council is recruiting a Database Administrator (DBA). As part of the interview, you are asked to explain any two key responsibilities the DBA will perform in managing the city's digital systems. **(02 marks)**

vi. While analyzing staff records at Mbale School of Nursing, the system designer asks you to explain the relational model concepts used in the database. Using this scenario, explain the terms Tuple, Attribute, and Foreign Key. **(03marks)**

vii. The HR system at Entebbe International Airport stores employee details using various keys. Using this airport HR system as an example, define:

a. Candidate Key **(01 marks)**

b. Composite Key **(01 marks)**

c. Strong Entity Set **(01 marks)**

viii. You have been asked to review the E/R diagram for the new National Farmers'

Registration System. Using this scenario, briefly explain:

a. Relationship Set **(02 marks)**

b. Simple Attribute vs. Composite Attribute **(02 marks)**

c. Many–Many Relationship **(02 marks)**

d. Entity Integrity vs. Referential Integrity **(04 marks)**

ix. A development team is building a digital land registry system for a district. They want you to explain the four major stages of designing the database. Using this scenario, explain Requirements Analysis, Conceptual Design, Logical Design, and Physical Design. **(04 marks)**

Question 2:

QUESTION TWO (40 MARKS)

Greenfields University is implementing a new Human Resource (HR) and Payroll information system to manage its staff and payments. Currently, staff details (such as StaffID, FirstName, MiddleName, LastName, Department, Date of Birth, National ID, Email) and salary-related information (basic salary, allowances, deductions) are stored in several Excel sheets managed separately by the HR, Finance, and ICT departments. This has led to duplicated data, inconsistent staff records, and frequent errors in salary processing. The new system will be built using a MySQL relational database with tables such as Staff(...), Payments(...), and Salary(...). You have been hired as the database designer to normalize the data, enforce integrity constraints, and write the necessary SQL statements to support the system.

i. In a meeting with Greenfields University management, the HR Manager complains that staff data is “scattered and repetitive” across multiple Excel sheets. Using this HR & Payroll scenario, define Normalization in the context of relational databases and relate it to this situation.
(04 marks)

ii. As you review the existing Excel-based records, you notice anomalies such as different salaries for the same staff member in different sheets. Using the Greenfields University case, give TWO reasons why normalization is necessary for the new relational database. **(04 marks**)

iii. During the design of the new HR & Payroll system, you realize that some tables must be adjusted to accommodate new staff attributes and to remove redundant fields. In the context of Greenfields University, state TWO common types of schema modifications/alterations that may be performed on the relations as the system

evolves. **(04 marks)**

iv. The Finance Director insists that the Staff and Salary tables must be easy to maintain and should not produce conflicting data. Using the HR & Payroll system at Greenfields University, state any TWO properties of a well-normalized relation that would help achieve this.

(04 marks)

v. While analyzing the relationships between StaffID, Department, and Salary in the Greenfields University database, you are asked to justify how these relationships guide the table structures. Using this case, explain the purpose of functional dependencies in database design. **(04 marks**)

vi. You are tasked with ensuring that the Staff and Salary tables in the Greenfields University database comply with the main normal forms to reduce redundancy and update anomalies. Using examples from the HR & Payroll data, state the conditions for each of the following normal forms:

a. First Normal Form (1NF) **(04 marks**)

b. Second Normal Form (2NF) **(04 marks**)

c. Third Normal Form (3NF) **(04 marks**)

vii. To avoid paying salaries to non-existent staff or assigning salary records to invalid StaffID values, you are required to apply relational integrity constraints on the Staff and related tables in the Greenfields University database. Define the two major relational integrity constraints and explain why each is important in the context of the HR & Payroll system. **(08 marks**)

SECTION B

Attempt any Three Questions from Section B

Question 1:

QUESTION THREE (20 MARKS)

Greenfields Bank is implementing a new Human Resource (HR) and Payroll Information System to manage its employees and salary payments. Currently, employee details (such as StaffID, FirstName, MiddleName, LastName, Department, DateOfBirth, NationalID, Email) and salary-related information (basic salary, allowances, deductions) are stored in multiple Excel sheets managed separately by the HR, Finance, and ICT departments. This situation has resulted in duplicated records, inconsistent employee data, and frequent errors in payroll processing. To address these challenges, the bank is deploying a MySQL-based HR & Payroll system with relational tables such as Staff(...), Payments(...), and Salary(...). You have been hired as the database designer to normalize the data, enforce integrity constraints, and write the necessary SQL statements to support the new system. Using standard MySQL syntax, write SQL statements to perform the following operations on the existing tables:

i. Add two columns DateOfBirth and NationalID to the Staff table. **(02 marks)**

ii. Modify the column DepartmentName in the Staff table to hold up to 100 characters. **(02 marks)**

iii. Remove the column MiddleName from the Staff table. **(02 marks)**

iv. Rename the column Email to OfficialEmail in the Staff table. **(02 marks)**

v. Ensure that a staff member's age must be at least 18 years. **(02 marks)**

vi. Restrict the Department field in the Staff table to only: HR, Finance, ICT. **(02 marks)**

vii. Add a foreign key to the Payments table referencing Staff(StaffID). **(02 marks)**

viii. Update the staff name to 'Nansamba Ruth' and email to 'rnansamba@greenfieldsbank.co.ug' where StaffID = 'ST110'. **(02 marks)**

ix. Retrieve StaffID, FirstName, LastName for the staff member whose StaffID = 'ST205'. (02 marks)

x. Compute the total salary expenditure from the Salary table. **(02 marks)**

Question 2:

QUESTION FOUR (20 MARKS)

Mr. Musiime Johns, the Sales Manager of Fair Price Kabale Supermarket, has contracted you to design a Point of Sale (POS) System to be used in the supermarket's daily transactions. According to Mr. Musiime, the current system is entirely manual. Sales representatives use mental calculations and record daily transactions in books. This approach is error-prone and

has resulted in losses for the company, since staff often make miscalculations. It has also scared away customers because, on several occasions, customers are cheated as a result of inaccurate calculations. The NEW system should help the company reduce these losses by minimizing miscalculations and enabling Fair Price Kabale Supermarket to serve customers efficiently and effectively. Mr. Musiime has requested you to design a database-driven solution that can record customer details plus the details of different daily transactions as they happen. This will help the company follow up with customers (since some customers take goods on credit) and reduce the number of errors committed while computing transactions manually, thereby improving the profit margin and customer retention. The system should be able to store CUSTOMER ID NO, CUSTOMER NAME, TELEPHONE NUMBER, and PHYSICAL ADDRESS of customers. In addition, it should store ITEM ID, ITEM NAME, UNIT PRICE for different items, QUANTITY purchased by a particular customer, and the AMOUNT PAID by the customer.

REQUIRED:

Using SQL only, write the necessary SQL statements (queries, views, stored procedures, functions, and/or triggers) to implement the following functionality. You may assume that appropriate tables (such as CUSTOMER, ITEM, SALE, and SALEITEM) exist or show their essential structure before writing the SQL code.

i. Write a SQL stored procedure or function that, for a given sale (or customer and date), calculates the total amount to be paid by a specific customer by multiplying the quantity bought of each item by the unit price of that item and summing the results for all items in that sale. Display the total amount for that customer's transaction. **(04 marks**)

ii. Write a SQL query, stored procedure, or function that displays the balance as either a negative or positive figure by subtracting the total amount billed from the amount paid by the customer (BALANCE = AMOUNT_PAID – TOTAL_BILLED). **(04 marks)**

iii. Write a SQL query or view that displays the total daily sales by adding up all the sales for a given transaction date. Ensure that the result clearly shows the transaction date and the corresponding total sales amount**.**
(04 marks)

iv. The management also needs to know the average inventory figure and the turnover of merchandise. Assume that BEGINNING INVENTORY, ENDING INVENTORY, and COST OF GOODS SOLD are stored in an INVENTORY table.

a. Write a SQL query or view that calculates the Average Inventory for a given period using the formula: Average Inventory = (Beginning Inventory + Ending Inventory) / 2
(04 marks)

b. Write a SQL query or stored function that calculates the Turnover for a given period using the formula:Turnover = Cost of Goods Sold / Average Inventory
(04 marks)

Question 3:

QUESTION FIVE (20 MARKS)

CityCare Hospital stores patient admission records in separate departmental systems, causing duplicate data and billing inconsistencies.

REQUIRED:

i. Identify four data integrity issues. **(4 marks**)

ii. Propose a normalized schema up to 3NF. **(6 marks**)

iii. Write SQL to create any two tables with PK and FK. **(4 marks**)

iv. Write a SELECT query to list total billing amounts per patient using GROUP BY and HAVING (only show totals above 500,000). **(3 marks**)

v. Retrieve a list of patients ordered by AdmissionDate in descending order. **(3 marks**)

Question 4:

QUESTION SIX (20 MARKS)

Mukwano Industries would like to computerize its payroll system to help the accountant calculate employees' salaries. The database should store employees' basic pay and be able to compute all necessary allowances and deductions. Each employee:

- Receives a BASIC PAY based on his/her rank and time served in the organization.
- Is required (as a must) to work overtime of 10 hours in a month.
- Overtime is calculated at a rate of UGX 30,000 for every extra hour worked.

ALLOWANCES:

- Gross Pay = Basic Pay + Overtime + Housing Allowance + Transport Allowance + Medical Allowance
- Housing Allowance = 8% of Gross Pay
- Transport Allowance = 5% of Gross Pay
- Medical Allowance = 6% of Gross Pay

DEDUCTIONS:

- NSSF = 15% of Gross Pay
- Pay As You Earn (PAYE) tax is calculated as follows:

- Any employee earning salary less than UGX 200,000 does not pay tax.
- If Gross Pay is more than UGX 200,000 but less than UGX 350,000: PAYE = 10% of (Gross Pay – 200,000)
- If Gross Pay is more than UGX 350,000 but less than UGX 500,000: PAYE = 20,000 + 20% of (Gross Pay – 350,000)
- If Gross Pay is more than UGX 500,000: PAYE = 60,500 + 30% of (Gross Pay – 500,000)

- Net Pay:
  - Net Pay = Gross Pay – (Total Deductions, including PAYE and NSSF)

Note: Total Allowances = Housing Allowance + Transport Allowance + Medical Allowance

REQUIRED:

Design a suitable PAYROLL database structure using SQL (for example, EMPLOYEE and PAYROLL tables). Then, using SQL only, write stored functions or stored procedures that implement the following calculations. Clearly indicate parameters and return values for each.

a) Write a SQL stored function/procedure to calculate the:

i. i. Housing Allowance (02 marks)

ii. ii. Transport Allowance (02 marks)

iii. iii. Medical Allowance (02 marks)

b) Write a SQL stored function/procedure to calculate:

i. i. Total Overtime for the mandatory 10 hours per month (02 marks)

ii. ii. Gross Pay (Basic Pay + Total Overtime + Total Allowances) (02 marks)

iii. iii. NSSF as 15% of Gross Pay (03 marks)

iv. iv. PAYE according to the given tax bands (04 marks)

v. v. Net Pay (Gross Pay – Total Deductions) (03 marks)

Your answers should be written purely in SQL (for example, MySQL stored procedures and functions). Assume that a web interface would simply supply input values and display results returned by your SQL code.

Question 5:

QUESTION SEVEN (20 MARKS)

Pearl Logistics Ltd manages deliveries using shared spreadsheets, causing inconsistencies in route and driver data.

REQUIRED:

i. Discuss four challenges of migrating from spreadsheets to MySQL. **(4 marks**)

ii. Develop a text-based ER diagram for drivers, trucks, routes, deliveries, and fuel usage. **(6 marks**)

iii. Write a trigger to update RouteStatus when a delivery is marked 'Completed'. **(4 marks**)

iv. Write a SELECT query to show total fuel consumption per truck, grouped by TruckNumber, and filter trucks consuming more than 200 liters. **(3 marks**)

v. Display all deliveries ordered by DeliveryDate (ascending). **(3 marks**)

Question 6:

QUESTION EIGHT (20 MARKS)

Using SQL only (for example, MySQL), design and implement the database logic for a simple marks management system where a student's coursework assignment contributes 10%, a test contributes 20%, and the final exam contributes 70% to the final mark.

REQUIRED:

i. Using SQL DDL statements, create a database and at least one table (for example, STUDENT_MARKS) to store the following fields: STUDENT_ID, STUDENT_NAME, ASSIGNMENT_MARK, TEST_MARK, EXAM_MARK, and FINAL_MARK. Clearly show the CREATE TABLE statement(s). **(04 marks)**

ii. Write a SQL VIEW or SELECT statement that returns, for each student, the student ID, name, assignment mark, test mark, exam mark, and final mark (even if initially NULL), in a format that could be directly consumed by a web application to display results. **(04 marks)**

iii. Write a SQL stored function or stored procedure that computes the FINAL_MARK for a student, given ASSIGNMENT_MARK, TEST_MARK, and EXAM_MARK, using the following weights:

- Assignment Mark = 10%
- - Test Mark = 20%
- - Exam Mark = 70%

The function/procedure should return the computed FINAL_MARK. **(06 marks)**

iv. Write a SQL stored function that takes the FINAL_MARK as a parameter and returns the corresponding GRADE as a text value based on the following scale**:** **(06 marks)**

- 80 – 100 : Excellent
- 75 – 79 : Extremely Good
- 70 – 74 : Very Good
- 65 – 69 : Good
- 60 – 64 : Fairly Good
- 55 – 59 : Fair
- - 0 – 54 : Poor

Your answer should consist of the necessary CREATE TABLE, CREATE VIEW, and CREATE FUNCTION/PROCEDURE statements written entirely in SQL.

Question 7:

QUESTION NINE (20 MARKS)

Apex University uses an Excel file to track course registrations, resulting in mismatched student-course records.

REQUIRED:

i. Identify four causes of data anomalies. **(4 marks)**

ii. Normalize the data up to 3NF. **(6 marks)**

iii. Write SQL queries: (i) retrieve courses taken by a student; (ii) compute CGPA. **(4 marks)**

iv. Write a SELECT statement showing the number of students registered per course using GROUP BY. Filter courses with more than 50 students (HAVING). **(3 marks)**

v. Retrieve a list of students ordered alphabetically by LastName. **(3 marks)**

Question 8:

QUESTION TEN (20 MARKS)

Sunrise Microfinance Bank maintains customer loan records using multiple Excel sheets managed by different officers. Each sheet contains repeated customer information (CustomerName, PhoneNumber, Branch, LoanType, InterestRate, LoanAmount, OfficerName). Due to duplication and inconsistent updates, the bank frequently encounters problems such as:

- Conflicting customer contact details
- Inconsistent loan types and interest rates
- Difficulty generating accurate loan portfolio summaries

The bank is implementing a centralized MySQL database and has hired you to design a normalized data structure.

REQUIRED:
Using the scenario above, answer the following questions:

i. Identify five data anomalies that are likely to occur in the current Excel-based system. **(5 marks)**

ii. Using the sample unnormalized record below, convert it to 1NF. **(5 marks)**

- CustomerName: John Mwesige
- PhoneNumber: 0772456987
- Branch: Kampala
- Loans: [(Agricultural Loan, 12%, 1,500,000), (Business Loan, 15%, 3,000,000)]
- OfficerName: Sarah Nanyonjo

iii. Normalize the 1NF structure into 2NF, clearly showing the tables and primary keys. **(5 marks)**

Normalize the 2NF design into 3NF, removing all transitive dependencies. Present the final schema.

(5 marks)

Question 9:

QUESTION TWELVE (20 MARKS)
SmartBank Uganda processes loan applications manually leading to security risks and inconsistent applicant data.

REQUIRED:

i. Explain four security vulnerabilities. **(4 marks)**

ii. Propose a relational schema ensuring referential integrity. **(6 marks)**

iii. Write PL/SQL procedures to: (i) insert a loan application; (ii) update risk ratings. **(4 marks)**

iv. Write a SELECT query that groups loans by LoanType and calculates average AmountRequested. Include only LoanTypes with more than 10 applications. **(3 marks)**

Display all applicants sorted by NationalID. **(3 marks)**

Question 10:

QUESTION ELEVEN (20 MARKS)

FreshFarm Exporters uses paper forms to track consignments, causing revenue losses due to manual calculation errors.

REQUIRED:

i. Describe four consequences of manual tracking. **(4 marks)**

ii. Develop conceptual and logical models for automated tracking. **(6 marks)**

iii. Write SQL functions to compute shipment value. **(4 marks)**

iv. Write a SELECT query to show total quantity shipped per produce type using GROUP BY and HAVING quantities above 1,000 kg. **(3 marks)**

v. Display consignments sorted by ShipmentDate (descending). **(3 marks)**

Question 11:

QUESTION TWELVE (20 MARKS)

SkyTech Logistics Ltd is a rapidly growing delivery company operating in major towns across Uganda. The company keeps all its operational data in a single unstructured table named DeliveryRecords, which stores information about customers, packages, delivery officers, payment details, and delivery routes. The current structure of the DeliveryRecords table is shown below:

DeliveryRecords(CustomerID, CustomerName, CustomerPhone, PackageID, PackageType, PackageWeight, DeliveryOfficerID, OfficerName, OfficerPhone, RouteID, RouteName, RouteDistance, PaymentID, PaymentMethod, AmountPaid, DeliveryDate, CustomerLocation)

Management has noticed several issues including data redundancy, frequent anomalies during updates, and inconsistent payment records. They have asked you, as the database programmer, to analyze the table and redesign it into a well-structured relational schema.

i. Identify and describe at least FIVE functional dependencies that exist in the DeliveryRecords table. Explain why each dependency is important for understanding data relationships. (08 Marks)

ii. Normalize the DeliveryRecords table to at least Third Normal Form (3NF). Clearly show the steps taken from UNF → 1NF → 2NF → 3NF, including the resulting relational schemas at each stage. (10 Marks)

iii. Briefly explain TWO potential risks of failing to normalize operational databases in fast-growing companies like SkyTech Logistics Ltd. (02 Marks)

Question 12:

QUESTION TWELVE (20 MARKS)

FreshCart Online Supermarket operates a nationwide e-commerce platform where customers order groceries and household items. The company stores operational data in the following relational schema:

Customers(CustomerID, CustomerName, Location)
Orders(OrderID, CustomerID, OrderDate, TotalAmount)
OrderItems(OrderID, ProductID, Quantity)
Products(ProductID, ProductName, Category, UnitPrice)

Due to an increase in data analytics needs, the company wants you, as the database programmer, to write precise data retrieval expressions using **Relational Algebra** and **Relational Calculus** for several analytical tasks.

a) Using Relational Algebra, write expressions to retrieve the following information:
i. All customers who placed orders worth more than 200,000 UGX. (04 Marks)
ii. The names of products ordered by customers located in 'Kampala'. (04 Marks)
iii. A list of distinct product categories that appear in customer orders. (02 Marks)

b) Using Tuple Relational Calculus (TRC) or Domain Relational Calculus (DRC), express the following queries:
i. Retrieve all orders (OrderID and OrderDate) made by customers whose location is 'Entebbe'. (04 Marks)
ii. Retrieve the names of customers who have ordered at least one product in the 'Beverages' category. (04 Marks)

c) Explain TWO advantages of relational calculus in formal database query specification. (02 Marks)