



G.C.E. Advanced Level - 2024 Preparation Test – August 2024

Duration : 3 hrs.

This paper will be discussed in the class time

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Important:

- * *This paper consist of 3 pages.*
- * *This question paper comprises of two parts, Part A and Part B. The time allotted for both parts is three hours.*
- * *Use of calculators is not allowed.*

Part A : Structured Essay:

- * *Answer all the questions on this paper itself.*
- * *Note that space provided is sufficient for your answers and that extensive answers are not expected.*

Part B : Essay:

- * *This part consist of 6 questions and only four questions should be answered.*
- * *At the end of the time allotted for this paper, tie the two parts together so that Part A is on top of Part B before handing them over to the Supervisor.*

For Examiner's Use Only:

For the Second Paper

Part	Question No	Marks
A	1	
	2	
	3	
	4	
B	5	
	6	
	7	
	8	
	9	
	10	
Total		

Part A

Question 1: Basic Concepts (Competency 1)

- a) Discuss the role of ICT in enhancing educational methodologies. Provide examples of specific ICT tools used in modern classrooms. **(4 marks)**
- (b) Explain the differences between Data, Information, and Knowledge. Illustrate with examples how an organization can convert data into valuable knowledge. **(3 marks)**
- (c) Evaluate the impact of cloud computing on business continuity planning. How does cloud computing contribute to disaster recovery? **(3 marks)**

Question 2: Number Systems (Competency 3)

- (a) Convert the following decimal numbers into their 8-bit two's complement representation:
 - (i) 45 (3 marks)
 - (ii) -73 (4 marks)
- (b) Perform the following operations using 8-bit two's complement arithmetic. State whether there is an overflow in each case:
 - (i) $45 + (-73)$ (2 marks)
 - (ii) $-58 - 39$ (1 mark)

Question 3: Logic Gates (Competency 4)

- (a) Construct the truth table for the following Boolean expression: $A'B + AB'A'B + AB'$. (3 marks)
- (b) Simplify the Boolean expression $(A+B')(A'+B)(A+B)(A'+B)$ using Boolean algebra rules. (4 marks)
- (c) Design a combinational circuit using AND, OR, and NOT gates to represent the simplified Boolean expression obtained in part (b). (3 marks)

Question 4: Operating Systems (Competency 5)

A system has 1GB of RAM and uses a paging system with a page size of 4KB. A program with a memory requirement of 50MB is loaded into the system.

- (a) Calculate the number of pages required to store the program in memory. (5 marks)
- (b) If the program is non-contiguous in memory, explain how the operating system uses paging to manage the program. (5 marks)

Part B

(Answer any four questions)

Question 5: Data Flow Diagram (DFD) - Scenario-Based Question

A mid-sized logistics company needs to develop a computer system to manage its operations. The company handles customer orders, warehouse inventory, transportation scheduling, and billing. The system needs to integrate the following processes:

- **Customer Order Management:** Customers place orders through an online portal or by contacting customer service. Orders need to be validated, confirmed, and passed to the warehouse for processing.
- **Warehouse Management:** The warehouse processes the order, checks the inventory, and prepares the items for shipment. The inventory system should update stock levels and generate alerts for low stock.
- **Transportation Scheduling:** Once the items are ready, the transportation department schedules the delivery, selects the appropriate vehicle, and tracks the shipment until it reaches the customer.
- **Billing and Payments:** After the order is shipped, the system generates an invoice and sends it to the customer. Payments are tracked, and reminders are sent for overdue accounts.

The system should allow for tracking customer orders from placement to delivery, manage inventory efficiently, and ensure that billing and payments are accurately recorded.

- (a) Identify the main processes that should be represented in a Data Flow Diagram (DFD) for this system. **(4 marks)**
- (b) Draw a Level 1 DFD for the system described above, showing the main processes, data stores, and external entities. **(8 marks)**
- (c) Choose one of the main processes identified in the Level 1 DFD and create a Level 2 DFD for that process, detailing its sub-processes and interactions. **(3 marks)**

Question 6: Databases (Competency 8)

- (a) Discuss the advantages and challenges of using an RDBMS over a NoSQL database in handling large volumes of unstructured data. (5 marks)
- (b) Define normalization. Normalize the following unnormalized table to the third normal form (3NF):

StudentID	StudentName	Course	Instructor
101	John Doe	Math	Dr. Smith
102	Jane Doe	Physics	Dr. Adams

- (c) Write the SQL commands to:
 - (i) Create a table named Course with fields CourseID, CourseName, and Instructor. (2 marks)
 - (ii) Insert a record into the Course table. (2 marks)
 - (iii) Retrieve all courses taught by Dr. Smith. (1 mark)

Question 7: Programming (Competency 9)

- (a) Write a Python function to calculate the Fibonacci series up to the 10th term. (5 marks)
- (b) Explain recursion with an example in Python. Write a recursive Python function to compute the factorial of a number. (5 marks)
- (c) Compare and contrast a list and a tuple in Python. In which scenarios would each be more appropriate? (5 marks)

Question 8: Logic Gates (Competency 4) - Scenario-Based Question

A security system in a building requires a control circuit to manage the locking mechanism of doors based on four inputs:

- A: Motion detected in the hallway.
- B: Door is closed.
- C: Security code entered correctly.
- D: Emergency button pressed.

The system should unlock the door if there is motion in the hallway, the door is closed, and the security code is entered correctly. However, if the emergency button is pressed, the door should remain locked regardless of the other conditions.

- (a) Construct the truth table for this scenario, identifying all possible states of the inputs and the corresponding output (Unlock or Lock). (7 marks)
- (b) Derive the Boolean expression from the truth table. (5 marks)
- (c) Simplify the Boolean expression using Boolean algebra and draw the corresponding logic circuit using AND, OR, and NOT gates. (3 marks)

Question 9: Networking (Competency 6) - Scenario-Based

A company has been allocated a Class B IP address range of 172.16.0.0/16. The company needs to divide this network into exactly 6 subnets for different departments: Sales, HR, IT, Finance, R&D, and Management. Each subnet should be large enough to accommodate at least 1000 usable IP addresses.

- (a) Calculate the appropriate subnet mask, network address, and broadcast address for each of the 6 subnets using CIDR notation. (8 marks)
- (b) Assign a subnet to each department and explain how the company can implement this network configuration. (4 marks)
- (c) Draw a network diagram showing the six subnets and how they connect to a central router, including any necessary routers or switches for interconnection. (3 marks)

Question 10: ER Diagram - Scenario-Based Question

A large e-commerce platform requires a system to manage its operations, which include customers, orders, products, and suppliers. Here are the details:

- Customers: Each customer has a unique customer ID, name, contact details, and multiple shipping addresses. Customers may also earn loyalty points based on their total purchases, which are calculated by the system.
 - Orders: An order is placed by a customer and may include multiple products. Orders have a unique order ID, date, and payment details. A customer can have multiple orders, but each order is linked to only one customer.
 - Products: Each product has a unique product ID, name, description, and price. Products can be supplied by multiple suppliers, and each supplier can supply multiple products.
 - Suppliers: Suppliers have a unique supplier ID, name, and contact information. Some suppliers have contracts with the platform that need to be tracked.
- (a) Identify the entities, attributes, and relationships that should be represented in the ER diagram for this e-commerce system. (5 marks)
- (b) Draw the ER diagram based on the scenario, including entities, relationships, cardinalities, and any relevant attributes. (10 marks)

Marking Scheme

Question 1: Basic Concepts (Competency 1)

(a) Discuss the role of ICT in enhancing educational methodologies. Provide examples of specific ICT tools used in modern classrooms. (4 marks)

Answer:

- **ICT in Education:**
 - Enhances teaching and learning (1 mark).
 - Provides access to resources and supports different learning styles (1 mark).
- **Examples:**
 - **Interactive Whiteboards:** Allow visual and interactive learning (1 mark).
 - **E-learning platforms (e.g., Google Classroom, Moodle):** Facilitate remote learning and resource sharing (1 mark).

Mark Allocation:

- **Explanation of ICT's role:** (2 marks)
 - 1 mark for mentioning the enhancement of teaching and learning.
 - 1 mark for mentioning the provision of resources and support for different learning styles.
- **Examples:** (2 marks)
 - 1 mark each for examples like Interactive Whiteboards or E-learning platforms.

(b) Explain the differences between Data, Information, and Knowledge. Illustrate with examples how an organization can convert data into valuable knowledge. (3 marks)

Answer:

- **Definitions:**
 - **Data:** Raw facts, unprocessed (1 mark).
 - **Information:** Processed data with meaning (1 mark).
 - **Knowledge:** Insights derived from information (1 mark).
- **Example:**
 - **Data to Knowledge:** Analyzing sales data to improve marketing strategies (1 mark).

Mark Allocation:

- **Definitions:** (3 marks)
 - 1 mark each for correctly defining Data, Information, and Knowledge.
- **Example:** (1 mark)
 - 1 mark for a relevant example showing conversion of data to knowledge.

(c) Evaluate the impact of cloud computing on business continuity planning. How does cloud computing contribute to disaster recovery? (3 marks)

Answer:

- **Impact on Business Continuity:**
 - Ensures accessibility of resources during disruptions (1 mark).
- **Disaster Recovery Contribution:**
 - Cloud-based backup and redundancy (1 mark).
 - Multi-location data centers for failover (1 mark).

Mark Allocation:

- **Impact on Business Continuity:** (1 mark)
 - 1 mark for discussing how cloud computing ensures accessibility during disruptions.
- **Disaster Recovery:** (2 marks)
 - 1 mark for backup and redundancy.
 - 1 mark for multi-location data centers.

Question 2: Number Systems (Competency 3)

(a) Convert the following decimal numbers into their 8-bit two's complement representation:

(i) 45 (3 marks)

Answer:

1. **Step 1: Convert 45 to binary:**

- 45 in decimal is $32+8+4+132+8+4+1$.
- Binary representation: **00101101**
- **Marks Allocation:** 2 marks for correct binary representation.

2. **Step 2: Convert to 8-bit representation:**

- Since 45 is positive, no additional steps are needed.
- Final 8-bit two's complement representation: **00101101**
- **Marks Allocation:** 1 mark for recognizing no need for further conversion.

(ii) -73 (4 marks)

Answer:

1. **Step 1: Convert 73 to binary:**

- 73 in decimal is $64+8+164+8+1$.
- Binary representation: **01001001**
- **Marks Allocation:** 1 mark for correct binary representation.

2. **Step 2: Invert the bits:**

- Inverted binary: **10110110**
- **Marks Allocation:** 1 mark for correct bit inversion.

3. **Step 3: Add 1 to obtain the two's complement:**

- $10110110 + 1 = 10110111$
- **Marks Allocation:** 1 mark for correct addition.

4. **Final Answer:**

- Two's complement representation: **10110111**
- **Marks Allocation:** 1 mark for correct final representation.

(b) Perform the following operations using 8-bit two's complement arithmetic. State whether there is an overflow in each case:

(i) $45 + (-73)$ (2 marks)

Answer:

1. **Step 1: Convert 45 and -73 to two's complement:**

- 45: **00101101**

- -73: **10110111**
 - **Marks Allocation:** 1 mark for correctly identifying both two's complement values.
2. **Step 2: Add the two numbers:**
- **00101101 + 10110111 = 11000100**
 - **Marks Allocation:** 1 mark for correct addition.
3. **Step 3: Check for overflow:**
- No overflow occurs as there is no carry into the sign bit.

(ii) -58 - 39 (1 mark)

Answer:

1. **Step 1: Convert -58 and -39 to two's complement:**
- -58: **11000110**
 - -39: **11011001**
 - **Marks Allocation:** 1 mark for correctly converting both numbers.
2. **Step 2: Add the two numbers:**
- **11000110 + 11011001 = 10011111**
 - **Overflow check:** Evaluate if the final result causes overflow based on sign bit behavior.

Question 3: Logic Gates (Competency 4)

(a) Construct the truth table for the following Boolean expression: $A'B+AB'A'B+AB'$. (3 marks)

Answer:

A	B	A'	B'	A'B	AB'	A'B+AB'
0	0	1	1	0	0	0
0	1	1	0	1	0	1
1	0	0	1	0	1	1
1	1	0	0	0	0	0

Marks Allocation:

- **Correct A'A' and B'B' values:** 1 mark for all correct values.
- **Correct A'BA'B and AB'AB' calculations:** 1 mark for all correct intermediate values.
- **Final output A'B+AB'A'B+AB':** 1 mark for correct final column.

(b) Simplify the Boolean expression $(A+B')(A'+B)(A+B')(A'+B)$ using Boolean algebra rules. (4 marks)

Answer:

1. Step 1: Apply Distribution:

- $(A+B')(A'+B)=AA'+AB+B'A'+B'B(A+B')(A'+B)=AA'+AB+B'A'+B'B$
- **Marks Allocation:** 1 mark for correct distribution.

2. Step 2: Simplify Using Boolean Identities:

- $AA'=0$, $AA'=0$, $B'B=0$, $B'B=0$
- Remaining expression: $AB+A'B'AB+A'B'$
- **Marks Allocation:** 1 mark for each correct simplification step.

3. Final Answer:

- $AB+A'B'=A\oplus B$, $AB+A'B'=A\oplus B$ (Exclusive OR)
- **Marks Allocation:** 1 mark for correct final simplified expression.

(c) Design a combinational circuit using AND, OR, and NOT gates to represent the simplified Boolean expression obtained in part (b). (3 marks)

Answer:

1. Step 1: Draw the circuit representing $A\oplus B$:

- Implement $AB+A'B'AB+A'B'$ using AND, OR, and NOT gates.

- **Marks Allocation:** 2 marks for a correct circuit that implements the XOR function.

2. **Step 2: Label the inputs and outputs:**

- Ensure proper labeling for clarity.
- **Marks Allocation:** 1 mark for correct and clear labeling.



Question 4: Operating Systems (Competency 5)

A system has 1GB of RAM and uses a paging system with a page size of 4KB. A program with a memory requirement of 50MB is loaded into the system.

(a) Calculate the number of pages required to store the program in memory. (5 marks)

Answer:

1. Step 1: Convert the program size to bytes:

- $50\text{MB} = 50 \times 2^{20}$ bytes
- Marks Allocation: 1 mark for correctly converting MB to bytes using 2^{20}

2. Step 2: Calculate the page size in bytes:

- $4\text{KB} = 2^2 \times 2^{10}$ bytes = 2^{12} bytes
- Marks Allocation: 1 mark for correctly calculating the page size in bytes.

3. Step 3: Divide program size by page size to find the number of pages:

$$\bullet \text{ Number of pages} = \frac{50 \times 2^{20} \text{ bytes}}{2^{12} \text{ bytes per page}} = 50 \times 2^8 \text{ pages}$$

- **Marks Allocation:** 3 marks (1 mark for setting up the division correctly using powers of 2, and 2 marks for correctly expressing the final answer in powers of 2).

(b) If the program is non-contiguous in memory, explain how the operating system uses paging to manage the program. (5 marks)

Answer:

1. Step 1: Explain the concept of paging:

- Program is divided into pages, which are stored in available frames in physical memory.
- **Marks Allocation:** 2 marks for a clear and correct explanation of paging.

2. Step 2: Describe the role of the page table:

- The page table keeps track of the location of each page in physical memory.
- **Marks Allocation:** 2 marks for correctly explaining the page table's role.

3. Step 3: Explain address translation:

- The OS uses the page table to translate logical addresses into physical addresses.
- **Marks Allocation:** 1 mark for a correct explanation of address translation.

Question 5: Data Flow Diagram (DFD) - Scenario-Based Question

(a) Identify the main processes that should be represented in a Data Flow Diagram (DFD) for this system. (4 marks)

Answer:

- **Processes:**
 - **Customer Order Management:** Handling and processing customer orders (1 mark)
 - **Warehouse Management:** Inventory management and order preparation (1 mark)
 - **Transportation Scheduling:** Managing shipment and delivery schedules (1 mark)
 - **Billing and Payments:** Generating invoices and tracking payments (1 mark)

Mark Allocation:

- **Processes Identified:** (4 marks)
 - 1 mark per correctly identified process.

(b) Draw a Level 1 DFD for the system described above, showing the main processes, data stores, and external entities. (8 marks)

Answer:

- **Level 1 DFD:**
 - **Processes:** As identified in part (a) (4 marks)
 - **Data Stores:** Inventory, Orders, Payments, etc. (2 marks)
 - **External Entities:** Customers, Delivery Service, etc. (2 marks)

Mark Allocation:

- **Processes:** (4 marks)
 - 1 mark per process correctly represented.
- **Data Stores:** (2 marks)
 - 1 mark each for correct data stores.
- **External Entities:** (2 marks)
 - 1 mark each for external entities.

(c) Choose one of the main processes identified in the Level 1 DFD and create a Level 2 DFD for that process, detailing its sub-processes and interactions. (3 marks)

Answer:

- **Sub-processes:** Clearly defined (2 marks)
- **Interactions:** Logical flow (1 mark)

Mark Allocation:

- **Sub-processes:** (2 marks)
 - 1 mark for each correctly identified sub-process.
- **Interactions:** (1 mark)
 - 1 mark for correct interactions in the DFD



Question 6: Databases (Competency 8)

(a) Discuss the advantages and challenges of using an RDBMS over a NoSQL database in handling large volumes of unstructured data. (5 marks)

Answer:

- **Advantages:**
 - Data consistency, transaction support, complex queries. (2.5 marks)
- **Challenges:**
 - Scalability issues, rigid schema design, performance on large-scale unstructured data. (2.5 marks)

Mark Allocation:

- **Advantages:** (2.5 marks)
 - 1.25 marks for each well-explained advantage.
- **Challenges:** (2.5 marks)
 - 1.25 marks for each well-explained challenge.

(b) Define normalization. Normalize the following unnormalized table to the third normal form (3NF):

StudentID	StudentName	Course	Instructor
101	John Doe	Math	Dr. Smith
102	Jane Doe	Physics	Dr. Adams

Answer:

1. **Step 1: Identify anomalies:**
 - Identify and explain any data redundancy, insertion, update, or deletion anomalies in the table. (1 mark)
2. **Step 2: Convert to 1NF:**
 - Ensure each column has atomic values. (1 mark)
3. **Step 3: Convert to 2NF:**
 - Eliminate partial dependencies by creating separate tables for Student, Course, and Instructor. (2 marks)
4. **Step 4: Convert to 3NF:**
 - Remove transitive dependencies by ensuring that non-key attributes do not depend on other non-key attributes. (1 mark)

Mark Allocation:

- **Normalization Steps: (5 marks)**
 - 1 mark for identifying anomalies.
 - 1 mark for achieving 1NF.
 - 2 marks for achieving 2NF.
 - 1 mark for achieving 3NF.

(c) Write the SQL commands to:

(i) Create a table named Course with fields CourseID, CourseName, and Instructor. (2 marks)

Answer:

```
CREATE TABLE Course (  
    CourseID INT PRIMARY KEY,  
    CourseName VARCHAR(100),  
    Instructor VARCHAR(100)  
);
```

Mark Allocation:

- **Correct SQL syntax for table creation: (2 marks)**
 - 1 mark for correct syntax.
 - 1 mark for including all fields and primary key.

(ii) Insert a record into the Course table. (2 marks)

Answer:

```
INSERT INTO Course (CourseID, CourseName, Instructor)  
VALUES (101, 'Mathematics', 'Dr. Smith');
```

Mark Allocation:

- **Correct insertion command: (2 marks)**
 - 1 mark for correct SQL syntax.
 - 1 mark for correctly specifying field names and values.

(iii) Retrieve all courses taught by Dr. Smith. (1 mark)

Answer:

```
SELECT * FROM Course WHERE Instructor = 'Dr. Smith';
```

Mark Allocation:

- **Correct SELECT statement: (1 mark)**

- 1 mark for correct SQL command and condition.

Question 7: Programming (Competency 9)

(a) Write a Python function to calculate the Fibonacci series up to the 10th term. (5 marks)

Answer:

python

Copy code

```
def fibonacci_series(n):
    fib_series = [0, 1]
    while len(fib_series) < n:
        fib_series.append(fib_series[-1] + fib_series[-2])
    return fib_series[:n]

# Calculate Fibonacci series up to the 10th term
print(fibonacci_series(10))
```

Mark Allocation:

- **Function Definition:** (2 marks)
 - 1 mark for correct function syntax.
 - 1 mark for initializing the series with correct base cases (0, 1).
- **While Loop:** (2 marks)
 - 1 mark for correct loop to generate series.
 - 1 mark for appending correct sum of previous two terms.
- **Correct Output:** (1 mark)
 - 1 mark for correct output list up to the 10th term.

(b) Explain recursion with an example in Python. Write a recursive Python function to compute the factorial of a number. (5 marks)

Answer:

1. Explanation of Recursion:

- Recursion is a method of solving a problem where a function calls itself as a subroutine. This allows the function to be repeated several times as it processes the problem.
- **Example:** Calculating factorial.

2. Recursive Factorial Function:

python

Copy code

```
def factorial(n):  
    if n == 1:  
        return 1  
    else:  
        return n * factorial(n - 1)  
  
# Calculate factorial of 5  
print(factorial(5)) # Output should be 120
```

Mark Allocation:

- **Explanation of Recursion:** (2 marks)
 - 1 mark for correct definition.
 - 1 mark for mentioning function calling itself.
- **Factorial Function:** (3 marks)
 - 1 mark for correct base case (if n == 1: return 1).
 - 1 mark for correct recursive case (return n * factorial(n - 1)).
 - 1 mark for correct final output.

(c) Compare and contrast a list and a tuple in Python. In which scenarios would each be more appropriate? (5 marks)

Answer:

- **Comparison:**
 - **List:** Mutable, can be changed after creation (e.g., elements can be added, removed, or altered). (1.5 marks)
 - **Tuple:** Immutable, cannot be changed after creation (e.g., once a tuple is created, elements cannot be added, removed, or altered). (1.5 marks)
- **Example Scenarios:**
 - **List Example:** Used for collections of items that need to be modified (e.g., shopping cart items). (1 mark)
 - **Tuple Example:** Used for collections of items that should remain constant (e.g., days of the week). (1 mark)

Mark Allocation:

- **Comparison:** (3 marks)

- 1.5 marks for correct explanation of lists.
- 1.5 marks for correct explanation of tuples.
- **Example Scenarios: (2 marks)**
 - 1 mark for an appropriate scenario for using a list.
 - 1 mark for an appropriate scenario for using a tuple.

Question 8: Logic Gates (Competency 4) - Scenario-Based Question

(a) Construct the truth table for this scenario, identifying all possible states of the inputs and the corresponding output (Unlock or Lock). (7 marks)

Answer:

A B C D Output (Unlock/Lock)

0 0 0 0 Lock
 0 0 0 1 Lock
 0 0 1 0 Lock
 0 0 1 1 Lock
 0 1 0 0 Lock
 0 1 0 1 Lock
 0 1 1 0 Unlock
 0 1 1 1 Lock
 1 0 0 0 Lock
 1 0 0 1 Lock
 1 0 1 0 Lock
 1 0 1 1 Lock
 1 1 0 0 Lock
 1 1 0 1 Lock
 1 1 1 0 Unlock
 1 1 1 1 Lock

Mark Allocation:

- **Correct Inputs for A, B, C, D: (2 marks)**
 - 1 mark for correct combination of all inputs.

- **Correct Intermediate Calculations:** (2 marks)
 - 1 mark for correctly applying the logic for each condition.
- **Correct Output (Unlock/Lock):** (3 marks)
 - 1 mark for correctly determining output for each row.

(b) Derive the Boolean expression from the truth table. (5 marks)

Answer:

- **Step 1: Identify the conditions where the output is "Unlock":**
 - $A=1, B=1, C=1, D=0$
 - $A=0, B=1, C=1, D=0$
- **Step 2: Write the Boolean expression for each condition:**
 - For $A=1, B=1, C=1, D=0$: $ABCD'ABCD'$
 - For $A=0, B=1, C=1, D=0$: $A'BCD'A'BCD'$
- **Final Boolean Expression:** $ABCD'+A'BCD'ABCD'+A'BCD'$

Mark Allocation:

- **Identifying Conditions:** (2 marks)
 - 1 mark for each correctly identified condition leading to "Unlock".
- **Writing Boolean Expression:** (2 marks)
 - 1 mark for each correctly written expression.
- **Final Expression:** (1 mark)
 - 1 mark for correct final Boolean expression.

(c) Simplify the Boolean expression using Boolean algebra and draw the corresponding logic circuit using AND, OR, and NOT gates. (3 marks)

Answer:

- **Step 1: Simplify using Boolean Algebra:**
 - Combine like terms: $ABCD'+A'BCD'=BCD'(A+A')ABCD'+A'BCD'=BCD'(A+A')$
 - Since $A+A'=1$, simplify to $BCD'BCD'$
- **Step 2: Draw the Logic Circuit:**
 - Use AND gates to combine B, C, and D'D'.
 - Output the result as the control for the lock mechanism.

Mark Allocation:

- **Simplification Steps:** (2 marks)
 - 1 mark for combining like terms.
 - 1 mark for final simplified expression.

- **Logic Circuit Diagram:** (1 mark)
 - 1 mark for correct and complete circuit diagram.

Question 9: Networking (Competency 6) - Scenario-Based

A company has been allocated a Class B IP address range of 172.16.0.0/16. The company needs to divide this network into exactly 6 subnets for different departments: Sales, HR, IT, Finance, R&D, and Management. Each subnet should be large enough to accommodate at least 1000 usable IP addresses.

(a) Calculate the appropriate subnet mask, network address, and broadcast address for each of the 6 subnets using CIDR notation. (8 marks)

Answer:

1. **Step 1: Calculate the number of hosts required per subnet:**
 - Required hosts = 1000 (usable IPs) + 2 (network and broadcast) = 1002 hosts.
 - Minimum power of 2 = 1024 (as $2^{10} = 1024$).
 - **Marks Allocation:** 1 mark for correct calculation.
2. **Step 2: Determine the subnet mask:**
 - For 1024 hosts, subnet mask: /22/22
 - **Marks Allocation:** 2 marks for determining the correct subnet mask.
3. **Step 3: Calculate the network and broadcast addresses for each subnet:**
 - **Subnet 1 (Sales):** 172.16.0.0/22 to 172.16.3.255
 - **Subnet 2 (HR):** 172.16.4.0/22 to 172.16.7.255
 - **Subnet 3 (IT):** 172.16.8.0/22 to 172.16.11.255
 - **Subnet 4 (Finance):** 172.16.12.0/22 to 172.16.15.255
 - **Subnet 5 (R&D):** 172.16.16.0/22 to 172.16.19.255
 - **Subnet 6 (Management):** 172.16.20.0/22 to 172.16.23.255
 - **Marks Allocation:** 5 marks (0.5 marks for each correct network address, broadcast address).

(b) Assign a subnet to each department and explain how the company can implement this network configuration. (4 marks)

Answer:

1. **Step 1: Assign each subnet:**
 - Sales: 172.16.0.0/22

- HR: 172.16.4.0/22
- IT: 172.16.8.0/22
- Finance: 172.16.12.0/22
- R&D: 172.16.16.0/22
- Management: 172.16.20.0/22
- **Marks Allocation:** 2 marks for correct assignment.

2. Step 2: Implementation explanation:

- Each department's network is configured using routers to ensure inter-departmental communication.
- VLANs could be set up to separate traffic.
- **Marks Allocation:** 2 marks for a correct and logical explanation of the implementation.

(c) Draw a network diagram showing the six subnets and how they connect to a central router, including any necessary routers or switches for interconnection. (3 marks)

Answer:

1. Step 1: Draw a central router connecting to six switches/routers:

- Each router/switch represents a department's subnet.
- **Marks Allocation:** 2 marks for correct diagram showing all six subnets connected.

2. Step 2: Label the subnets correctly:

- **Marks Allocation:** 1 mark for correct labeling.

Question 10: ER Diagram - Scenario-Based Question

(a) Identify the entities, attributes, and relationships that should be represented in the ER diagram for this e-commerce system. (5 marks)

Answer:

1. **Entities:**

- **Customers:** CustomerID, Name, ContactDetails, ShippingAddresses (1 mark)
- **Orders:** OrderID, Date, PaymentDetails (1 mark)
- **Products:** ProductID, Name, Description, Price (1 mark)
- **Suppliers:** SupplierID, Name, ContactInfo, Contracts (1 mark)

2. **Relationships:**

- Customers place Orders
- Orders include Products
- Products are supplied by Suppliers
- **Marks Allocation:** 1 mark for identifying relationships.

(b) Draw the ER diagram based on the scenario, including entities, relationships, cardinalities, and any relevant attributes. (10 marks)

Answer:

1. **Step 1: Draw entities with attributes:**

- Include attributes for each entity and identify primary keys.
- **Marks Allocation:** 4 marks (1 mark per entity, including attributes and primary keys).

2. **Step 2: Establish relationships between entities:**

- Draw lines connecting entities and label the relationships (e.g., one-to-many, many-to-many).
- **Marks Allocation:** 4 marks (1 mark per correctly identified and labeled relationship).

3. **Step 3: Identify special features:**

- Identify weak entities, multi-valued attributes, derived attributes where necessary.
- **Marks Allocation:** 2 marks for correctly identifying and representing these features.