Database Management System (1333204) - Winter 2023 Solution

Milav Dabgar

January 20, 2024

Question 1(a) [3 marks]

Define: Field, Record, Metadata

Solution

Table 1. Basic Database Terms

Term	Definition
Field	A single unit of data representing a specific attribute in a database table (e.g., name, age, ID)
Record	A complete set of related fields that represents one entity instance (a row in a table)
Meta-data	Data that describes the structure, properties, and relationships of other data (”data about data”)

Mnemonic

Mnemonic: ”FRM: Fields Row-up as Metadata”

Question 1(b) [4 marks]

Define (i) E-R model (ii) Entity (iii) Entity set and (iv) attributes

Solution

Table 2. E-R Model Terminology

Term	Definition
E-R Model	A graphical approach to database design that models entities, their attributes, and relationships
Entity	A real-world object, concept, or thing that has an independent existence
Entity Set	A collection of similar entities that share the same attributes (represented as a table)
Attributes	Properties or characteristics that describe an entity (represented as columns in tables)

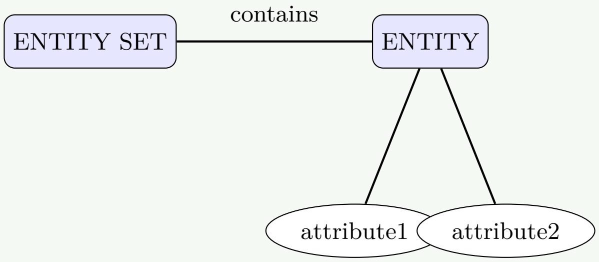


Figure 1. Entity and Entity Set Relationship

Mnemonic

Mnemonic: ”EEAA: Entities Exist As Attributes”

Question 1(c) [7 marks]

List the advantages and disadvantages of DBMS.

Solution

Table 3. DBMS Advantages vs Disadvantages

Advantages	Disadvantages
Data sharing: Multiple users can access simultaneously	**Cost**: Expensive hardware/software requirements
Data integrity: Maintains accuracy through constraints	**Complexity**: Requires specialized training
Data security: Controls access through permissions	**Performance**: Can be slow for large databases
Data independence: Changes to storage don’t affect apps	**Vulnerability**: Central failure point risks data loss
Reduced redundancy: Eliminates duplicate data	**Conversion costs**: Migrating from file systems is expensive

Mnemonic

Mnemonic: ”SIDSR vs CCPVC” (Sharing, Integrity, Data independence, Security, Redundancy vs Cost, Complexity, Performance, Vulnerability, Conversion)

OR

Question 1(c) [7 marks]

Write the full form of DBA. Explain the roles and responsibilities of DBA.

Solution

DBA: Database Administrator

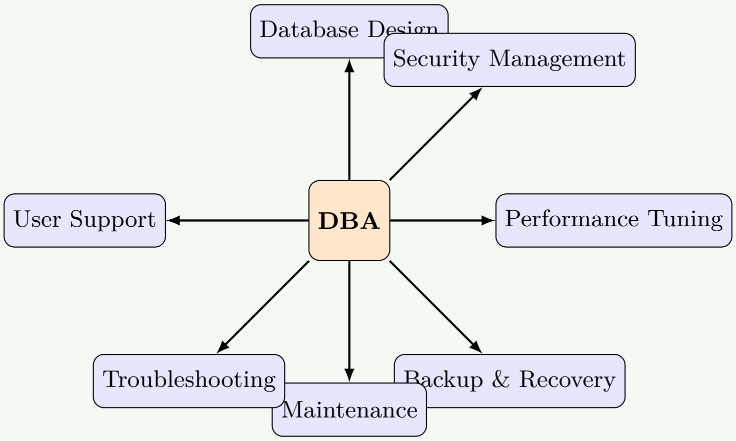


Figure 2. Roles of DBA

Table 4. Responsibilities of DBA

Role	Description
Database design	Creates efficient database schema
Security management	Sets up user access controls
Performance tuning	Optimizes queries and indexes
Backup & recovery	Implements data protection plans
Maintenance	Updates software and applies patches
Troubleshooting	Resolves database issues
User support	Trains and assists database users

Mnemonic

Mnemonic: ”SPBT-MUS” (Security, Performance, Backup, Troubleshooting, Maintenance, User support)

Question 2(a) [3 marks]

Explain single valued v/s multi-valued attributes with suitable examples

Solution

Table 5. Single vs Multi-valued Attributes

Attribute Type	Description	Examples
Single-valued	Holds only one value for each entity instance	Employee ID, Birth Date, Name
Multi-valued	Can hold multiple values for the same entity	Phone Numbers, Skills, Email Addresses

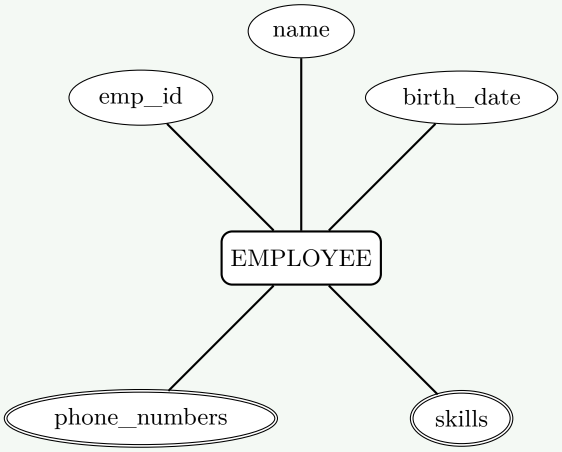


Figure 3. Attribute Types Example

Mnemonic

Mnemonic: ”SIM: Single Is Minimal, Multi Is Many”

Question 2(b) [4 marks]

Explain Key Constraints for E-R diagram

Solution

Table 6. Key Constraints

Key Constraint	Description
Primary Key	Uniquely identifies each entity in an entity set
Candidate Key	Any attribute that could serve as a primary key
Foreign Key	References primary key of another entity set
Super Key	Any set of attributes that uniquely identifies an entity

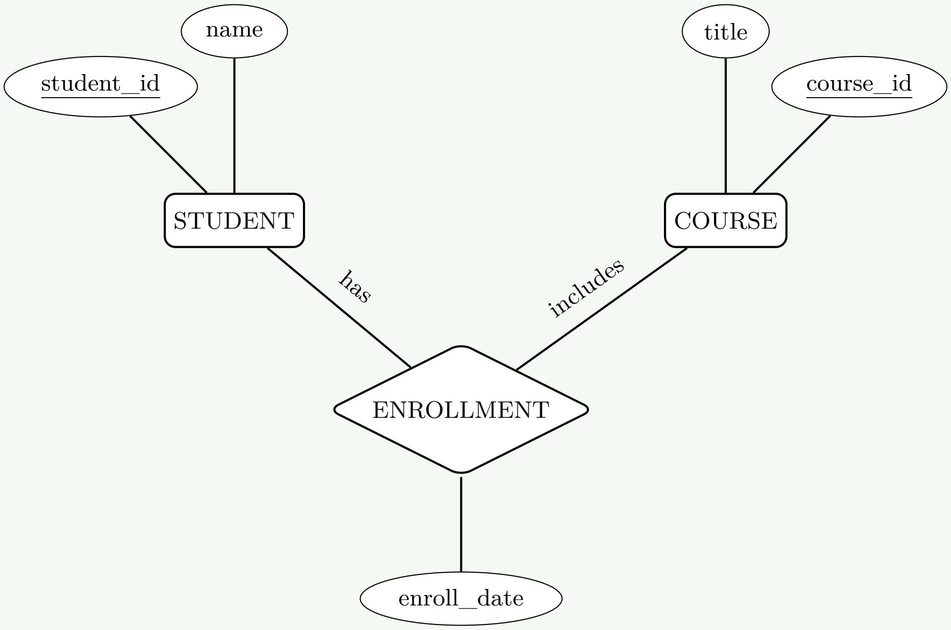


Figure 4. Key Constraints Example

Mnemonic

Mnemonic: ”PCFS: Primary Candidates Find Superkeys”

Question 2(c) [7 marks]

Construct an E-R diagram for banking management system.

Solution

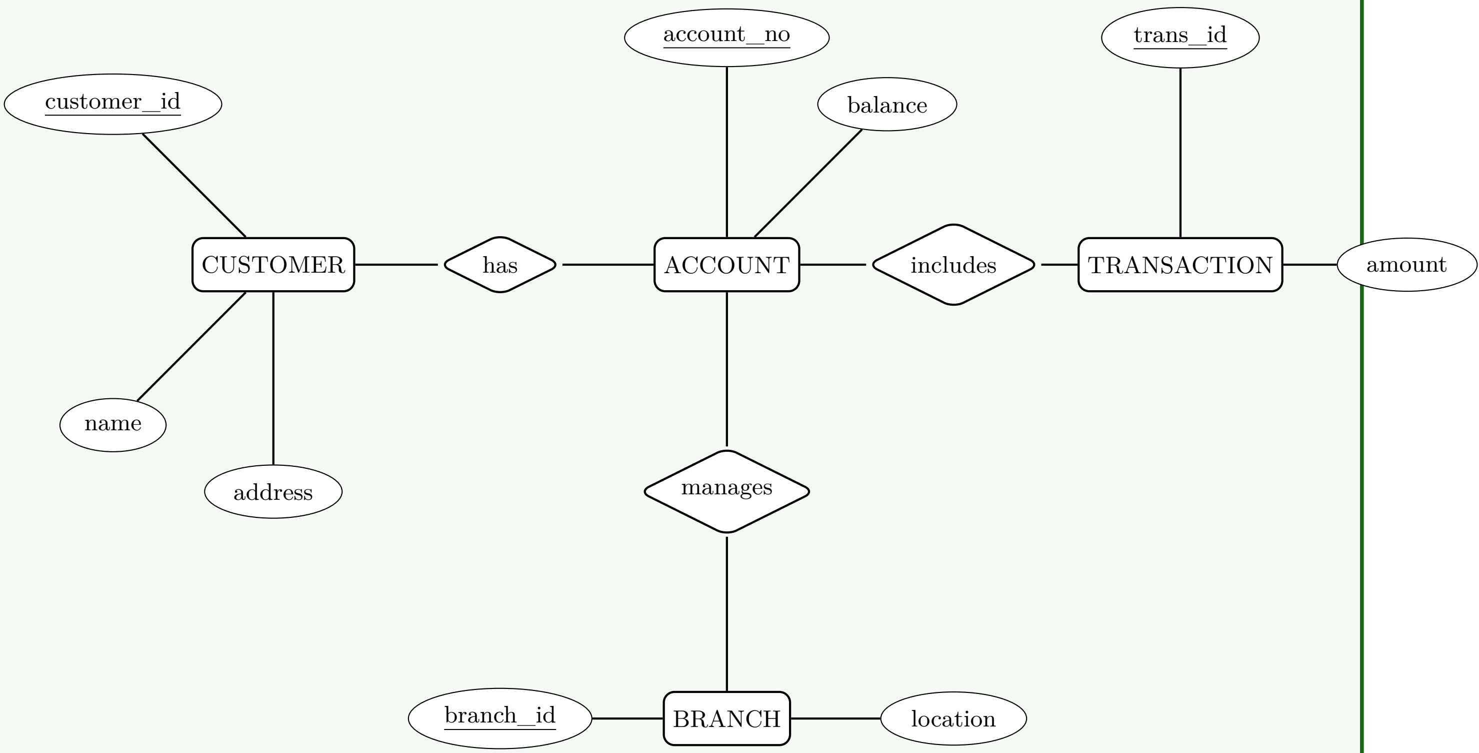


Figure 5. Banking Management System ER Diagram

Key Entities and Relationships:

- **Customer**: Stores customer information
- **Account**: Different account types (savings, checking)
- **Transaction**: Records deposits, withdrawals
- **Branch**: Different bank locations
- **Relationships**: Customers have accounts, accounts have transactions, branches manage accounts

Mnemonic

Mnemonic: ”CATB: Customers Access Transactions at Branches”

OR

Question 2(a) [3 marks]

Explain specialization v/s generalization with suitable examples

Solution

Table 7. Specialization vs Generalization

Concept	Direction	Description
Specialization	Top-down	Breaking a general entity into more specific sub-entities (Person → Student, Employee)
Generalization	Bottom-up	Combining similar entities into a higher-level entity (Car, Truck → Vehicle)

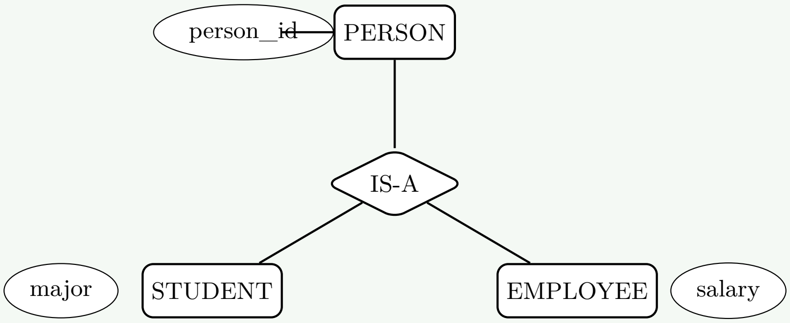


Figure 6. Specialization/Generalization Example

Mnemonic

Mnemonic: ”SG-TD-BU: Specialization Goes Top-Down, Generalization Builds Up”

OR

Question 2(b) [4 marks]

Define Chasp trap. Explain when it occurs. Explain the solution for Chasp trap

Solution

Chasp trap: A problem that occurs in ER diagrams when there are multiple paths between entities, causing ambiguity in relationship interpretations.

Table 8. Chasp Trap Details

Aspect	Description
Occurrence	When there are two or more distinct paths between entity types creating a cycle
Problem	Leads to incorrect or ambiguous query results
Solution	Break one of the relationships or add constraints to clarify the intended path

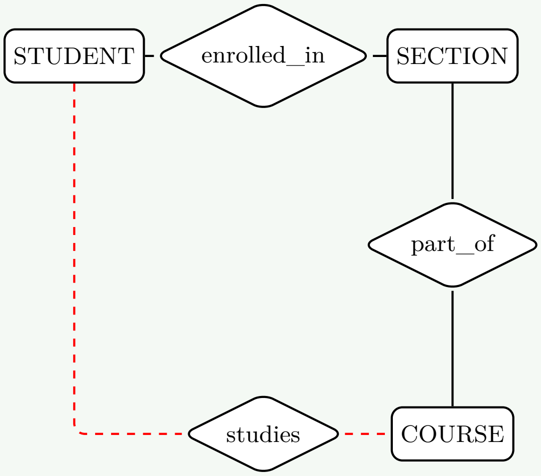


Figure 7. Chasp Trap (Cycle) Example

Mnemonic

Mnemonic: ”COP: Cycles Of Paths need breaking”

OR

Question 2(c) [7 marks]

Construct an E-R diagram for college management system.

Solution

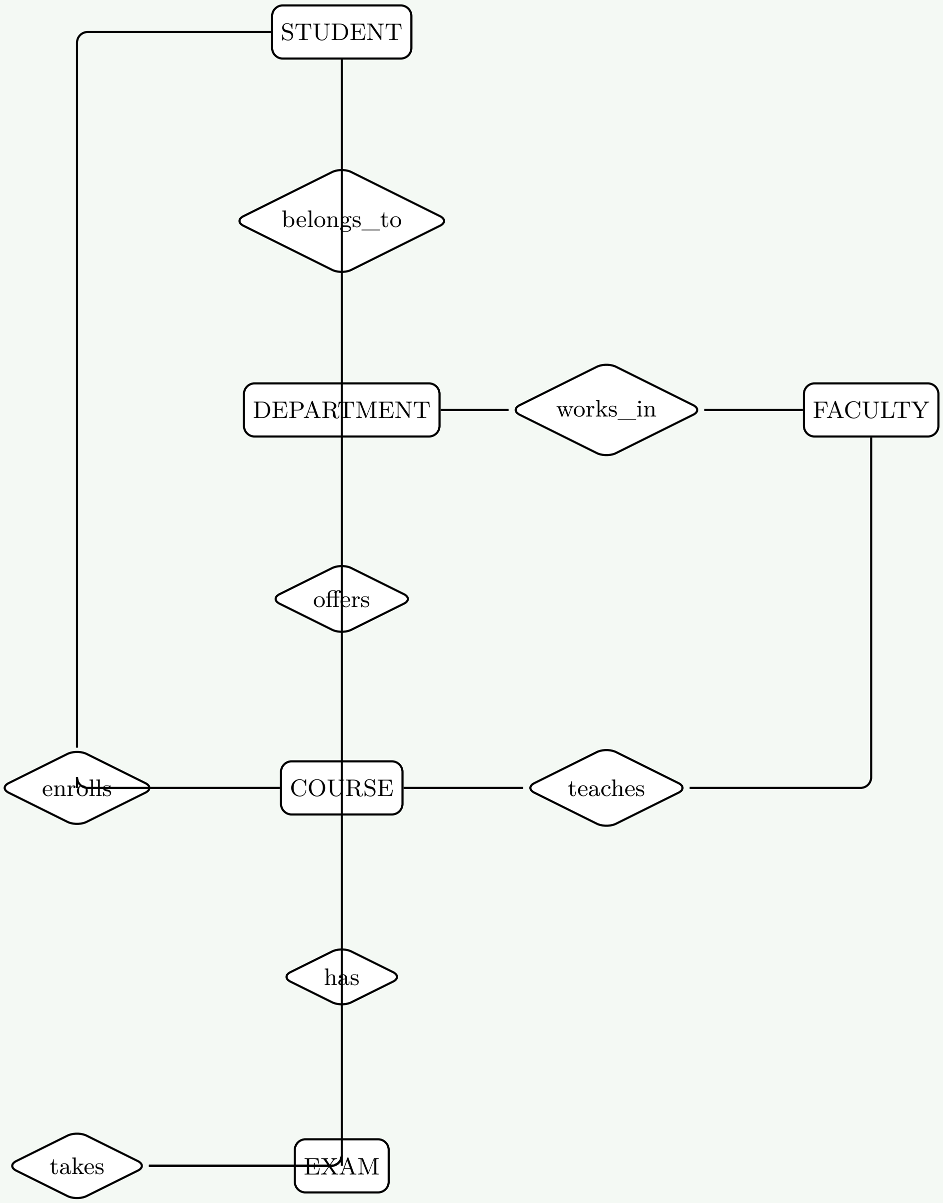


Figure 8. College Management System

Key Entities and Relationships:

- **Student**: Stores student details
- **Department**: Academic divisions
- **Faculty**: Teachers and professors
- **Course**: Subjects taught
- **Exam**: Evaluation events
- **Relationships**: Students enroll in courses, faculty teach courses, departments offer courses

Mnemonic

Mnemonic: ”SDFCE: Students Delight Faculty by Completing Exams”

Question 3(a) [3 marks]

Explain GROUP BY clause with example.

Solution

GROUP BY clause groups rows that have the same values into summary rows.

Table 9. GROUP BY Clause

Feature	Description
Purpose	Arranges identical data into groups for aggregate functions
Usage	Used with aggregate functions (COUNT, SUM, AVG, MAX, MIN)
Syntax	`SELECT column1, COUNT(*) FROM table GROUP BY column1;`

```sql
SELECT department, AVG(salary)
FROM employees
GROUP BY department;
```

Mnemonic

Mnemonic: ”GAS: Group And Summarize”

Question 3(b) [4 marks]

List Data Definition Language (DDL) commands. Explain any two DDL commands with examples.

Solution

DDL Commands: CREATE, ALTER, DROP, TRUNCATE, RENAME

Table 10. DDL Commands

Command	Description	Example
CREATE	Creates database objects like tables, views, indexes	`CREATE TABLE students (id INT PRIMARY KEY, name VARCHAR(50));`
ALTER	Modifies existing database objects	`ALTER TABLE students ADD COLUMN email VARCHAR(100);`
DROP	Removes database objects	`DROP TABLE students;`
TRUNCATE	Removes all records from a table	`TRUNCATE TABLE students;`

Mnemonic

Mnemonic: ”CADTR: Create, Alter, Drop, Truncate, Rename”

Question 3(c) [7 marks]

Perform the following Query on the ”Students” table having the field’s enr_no, name, percent, branch in SQL.

Solution

```sql
-- 1. Display all records in Students table
SELECT * FROM Students;

-- 2. Display only branch without duplicate value
SELECT DISTINCT branch FROM Students;

-- 3. Display all records sorted in descending order of name
SELECT * FROM Students ORDER BY name DESC;

-- 4. Add one new column to store address, named "address"
ALTER TABLE Students ADD address VARCHAR(100);

-- 5. Display all students belongs to branch "ICT"
SELECT * FROM Students WHERE branch = 'ICT';

-- 6. Delete all students having percent less than 60
DELETE FROM Students WHERE percent < 60;

-- 7. Display the students names starts with "S"
SELECT * FROM Students WHERE name LIKE 'S%';
```

Table 11. Query Explanations

Query	**Purpose**
SELECT	Retrieves data from tables
DISTINCT	Eliminates duplicate values
ORDER BY	Sorts results in specified order
ALTER TABLE	Modifies table structure
WHERE	Filters records based on conditions
DELETE	Removes records matching conditions
LIKE	Pattern matching in string comparison

Mnemonic

Mnemonic: ”SDOAWDL: Select Distinct Order Alter Where Delete Like”

OR

Question 3(a) [3 marks]

Explain GRANT command with syntax and example.

Solution

GRANT command gives specific privileges to users on database objects.

Table 12. GRANT Command

Component	Description
Syntax	`GRANT privilege(s) ON object TO user [WITH GRANT OPTION];`
Privileges	SELECT, INSERT, UPDATE, DELETE, ALL PRIVILEGES
Objects	Tables, views, sequences, etc.

```sql
GRANT SELECT, UPDATE ON employees TO user1;
GRANT ALL PRIVILEGES ON database_name.* TO user2 WITH GRANT OPTION;
```

Mnemonic

Mnemonic: ”GPO: Grant Privileges to Others”

OR

Question 3(b) [4 marks]

Compare Truncate command and Drop command.

Solution

Table 13. TRUNCATE vs DROP

Feature	TRUNCATE	DROP
Purpose	Removes all rows from table	Removes entire table structure
Structure	Keeps table structure intact	Deletes table definition completely
Recovery	Cannot be easily rolled back	Can be recovered until committed
Speed	Faster than DELETE	Quick operation
Triggers	Does not activate triggers	Does not activate triggers

```sql
-- Truncate example
TRUNCATE TABLE students;

-- Drop example
DROP TABLE students;
```

Mnemonic

Mnemonic: ”TRC-DST: Truncate Removes Contents, Drop Destroys Structure Totally”

OR

Question 3(c) [7 marks]

Write the Output of Following Query.

Solution

Table 14. SQL Query Outputs

Query	Output	Explanation
ABS(-23), ABS(49)	23, 49	Returns absolute value
SQRT(25), SQRT(81)	5, 9	Returns square root
POWER(3,2), POWER(-2,3)	9, -8	Returns x^y
MOD(15,4), MOD(21,3)	3, 0	Returns remainder after division
ROUND(123.446,1), ROUND(123.456,2)	123.4, 123.46	Rounds to specified decimal places
CEIL(234.45), CEIL(-234.45)	235, -234	Rounds up to nearest integer
FLOOR(-12.7), FLOOR(12.7)	-13, 12	Rounds down to nearest integer

```sql
SELECT ABS(-23), ABS(49);          -- 23, 49
SELECT SQRT(25), SQRT(81);         -- 5, 9
SELECT POWER(3,2), POWER(-2,3);    -- 9, -8
SELECT MOD(15,4), MOD(21,3);       -- 3, 0
SELECT ROUND(123.446,1), ROUND(123.456,2); -- 123.4, 123.46
SELECT CEIL(234.45), CEIL(-234.45);  -- 235, -234
SELECT FLOOR(-12.7), FLOOR(12.7);    -- -13, 12
```

Mnemonic

Mnemonic: ”ASPMRCF: Absolute Square Power Modulo Round Ceiling Floor”

Question 4(a) [3 marks]

List data types in SQL. Explain any two data types with example.

Solution

SQL Data Types: INTEGER, FLOAT, VARCHAR, CHAR, DATE, DATETIME, BOOLEAN, BLOB

Table 15. SQL Data Types

Data Type	Description	Example
INTEGER	Whole numbers without decimal points	`id INTEGER = 101`
VARCHAR	Variable-length character string	`name VARCHAR(50) = 'John'`
DATE	Stores date values (YYYY-MM-DD)	`birth_date DATE = '2000-05-15'`
FLOAT	Decimal numbers with floating point	`salary FLOAT = 45000.50`

```sql
CREATE TABLE employees (
    id INTEGER,
    name VARCHAR(50),
    salary FLOAT
);
```

Mnemonic

Mnemonic: ”IVDB: Integers & Varchars are Database Basics”

Question 4(b) [4 marks]

Explain Full function dependency with example.

Solution

Full Function Dependency: When Y is functionally dependent on X, but not on any subset of X.

Table 16. Full Function Dependency

Concept	Description	Example
Definition	Attribute B is fully functionally dependent on A if B depends on all of A	Student_ID → Name (full dependency)
Non-example	When attribute depends only on part of composite key	{Student_ID, Course_ID} → Student_Name (partial)

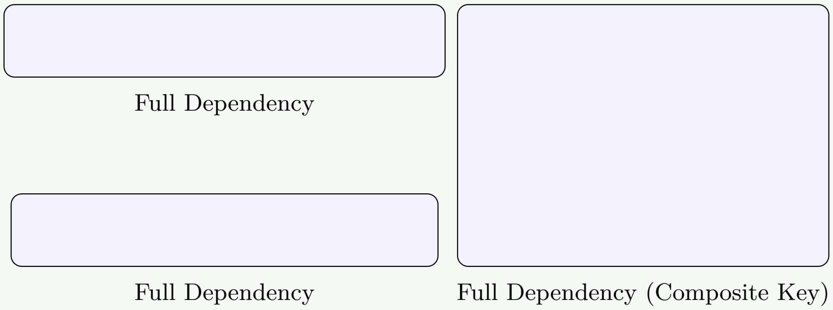


Figure 9. Full Functional Dependency

Mnemonic

Mnemonic: ”FFD: Full, not Fraction of Dependency”

Question 4(c) [7 marks]

Define normalization. Explain 2NF (Second Normal Form) with example and solution.

Solution

Normalization: Process of organizing database to minimize redundancy and dependency by dividing large tables into smaller tables and defining relationships between them.

2NF (Second Normal Form):

- A table is in 2NF if it is in 1NF and no non-prime attribute is dependent on any proper subset of candidate key.

Table 17. 2NF Violation

Table Schema	Problem
Order(Order_ID, Product_ID, Product_Name, Quantity, Price)	Product_Name depends on only Product_ID, not full key

Table 18. 2NF Solution

New Schema	Solution
Order(Order_ID, Product_ID, Quantity)	Only full key dependencies
Product(Product_ID, Product_Name, Price)	Product details depend only on Product_ID

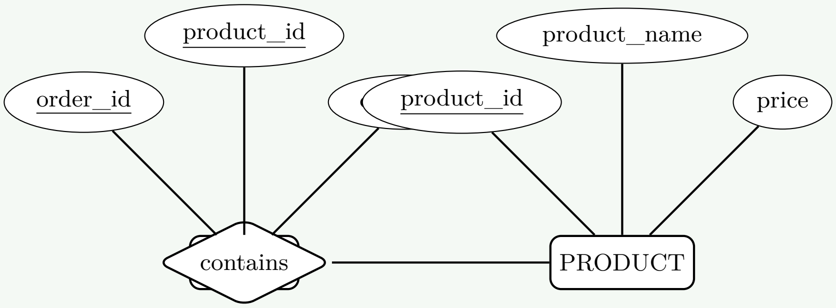


Figure 10. 2NF Solution ER Diagram

Mnemonic

Mnemonic: ”2NF-PPD: Partial dependency Problems Divided”

OR

Question 4(a) [3 marks]

Explain commands: 1) To_Number() 2) To_Char()

Solution

Table 19. Conversion Functions

Function	Purpose	Syntax	Example
TO_NUMBER()	Converts string to number	`TO_NUMBER(s, [fmt])`	`TO_NUMBER('123.45')`
TO_CHAR()	Converts number/date to string	`TO_CHAR(v, [fmt])`	`TO_CHAR(1234, '9999')`

```sql
-- Convert string to number
SELECT TO_NUMBER('123.45') FROM dual;  -- 123.45

```

```sql
-- Convert date to formatted string
SELECT TO_CHAR(SYSDATE, 'DD-MON-YYYY') FROM dual;  -- 20-JAN-2024

-- Convert number to formatted string
SELECT TO_CHAR(1234.56, '$9,999.99') FROM dual;  -- $1,234.56
```

Mnemonic

Mnemonic: ”NC: Numbers and Characters conversion”

OR

Question 4(b) [4 marks]

Explain 1NF (First Normal Form) with example and solution.

Solution

1NF (First Normal Form): A relation is in 1NF if it contains no repeating groups or arrays.

Table 20. 1NF Example

State	Schema/Example	Remark
Before 1NF	**Student(ID, Name, Courses)** (101, John, ”Math,Science,History”)	Multi-valued attribute Problem
After 1NF	**Student(ID, Name, Course)** (101, John, Math), (101, John, Science)...	Atomic values Solution

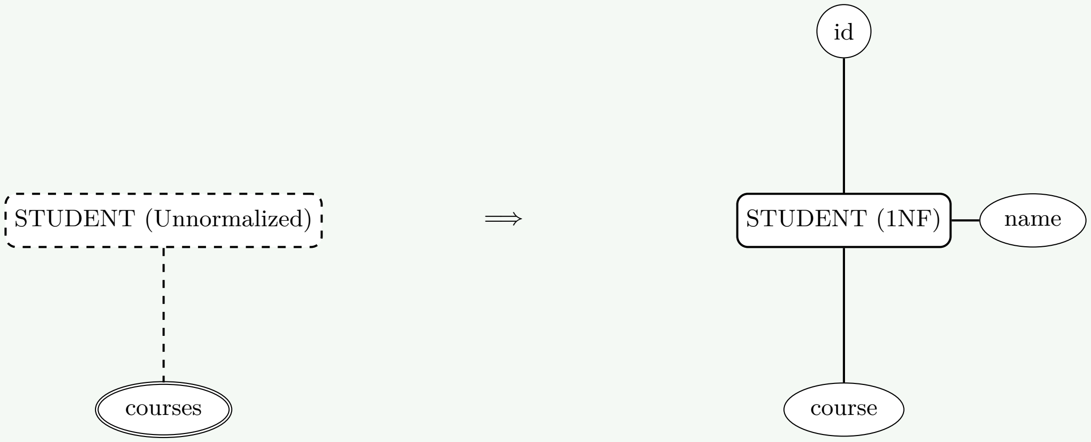


Figure 11. 1NF Conversion

Mnemonic

Mnemonic: ”1NF-ARM: Atomic values Remove Multivalues”

OR

Question 4(c) [7 marks]

Explain function dependency in SQL. Explain Partial function dependency with example.

Solution

Functional Dependency: A relationship where one attribute determines the value of another attribute. **Notation**: $X \rightarrow Y$ (X determines Y)
Partial Functional Dependency: When an attribute depends on only part of a composite primary key.

Table 21. Partial Dependency

Concept	Example	Explanation
Composite Key	{Student_ID, Course_ID}	Together forms primary key
Partial Dependency	{Student_ID, Course_ID} → Student_Name	Student_Name depends only on Student_ID
Problem	Update anomalies, data redundancy	Same student name repeated for multiple courses

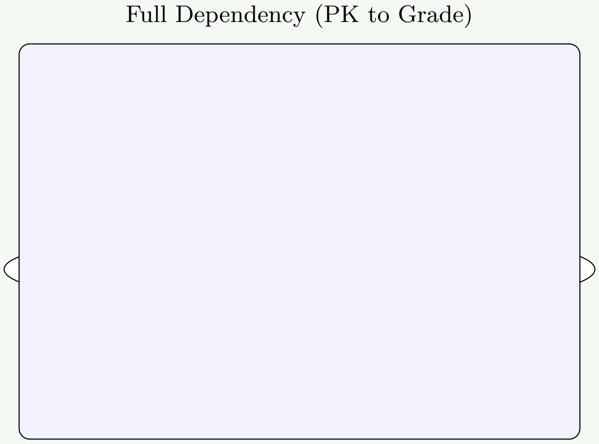


Figure 12. Partial Functional Dependency

Solution: Decompose into separate tables where each non-key attribute is fully dependent on the key.

Mnemonic

Mnemonic: "PD-CPK: Partial Dependency - Component of Primary Key"

Question 5(a) [3 marks]

Explain the properties of Transaction with example.

Solution

Transaction Properties (ACID):

Table 22. ACID Properties

Property	Description	Example
Atomicity	All operations complete successfully or none does	Bank transfer: debit and credit both happen or neither
Consistency	Database remains in valid state before and after	Account balance constraints remain valid
Isolation	Transactions execute as if they were the only one	Two users updating same record don't interfere
Durability	Committed changes survive system failure	Deposit remains even after power loss

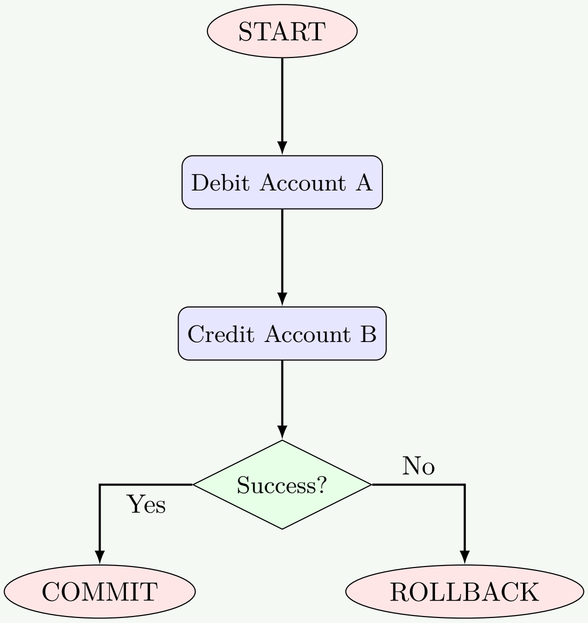


Figure 13. Atomicity Flowchart

Mnemonic

Mnemonic: ”ACID: Atomicity, Consistency, Isolation, Durability”

Question 5(b) [4 marks]

Write the Queries using set operators to find following using given ”Student” and ”CR” (Class Representative) tables.

Solution

```sql
-- 1. List the name of the persons who are either a student or a CR
SELECT Stnd_Name FROM Student
UNION
SELECT CR_Name FROM CR;

-- 2. List the name of the persons who are a student as well as a CR
SELECT Stnd_Name FROM Student
INTERSECT
SELECT CR_Name FROM CR;
```

```

-- 3. List the name of the persons who are only a student and not a CR
SELECT Stnd_Name FROM Student
MINUS
SELECT CR_Name FROM CR;

-- 4. List the name of the persons who are only a CR and not a student
SELECT CR_Name FROM CR
MINUS
SELECT Stnd_Name FROM Student;
```

Table 23. Set Operators

Set Operator	Purpose	Result for Example
UNION	Combines all distinct rows	Manoj, Rahil, Jiya, Rina, Jitesh, Priya
INTERSECT	Returns only common rows	Manoj, Rina
MINUS	Returns rows in first set but not second	Rahil, Jiya
MINUS (reversed)	Returns rows in second set but not first	Jitesh, Priya

Mnemonic

Mnemonic: ”UIMD: Union Includes, Minus Divides”

Question 5(c) [7 marks]

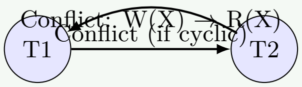
Explain Conflict Serializability in detail.

Solution

Conflict Serializability: A schedule is conflict serializable if it can be transformed into a serial schedule by swapping non-conflicting operations.

Table 24. Conflict Serializability Concepts

Concept	Description
Conflict operations	Two operations conflict if they access same data item and at least one is write
Precedence graph	Directed graph showing conflicts between transactions
Serializable	If precedence graph has no cycles, schedule is conflict serializable



No Cycle $\implies$ Serializable

Figure 14. Precedence Graph Concept

Example:

- T1: R(X), W(X)
- T2: R(X), W(X)

- **Serializable**: T1 → T2 or T2 → T1
- **Non-serializable**: R1(X), R2(X), W1(X), W2(X) (Creates cycle)

Mnemonic

Mnemonic: ”COPS: Conflict Operations Produce Serializability”

OR

Question 5(a) [3 marks]

Explain the concept of Transaction with example.

Solution

Transaction: A logical unit of work that must be either completely performed or completely undone.

Table 25. Transaction Phases

Phase	Description	Example
BEGIN	Marks start of transaction	START TRANSACTION
Execute	Database operations (read/write)	UPDATE account...
COMMIT/ROLLBACK	End transaction with success/failure	COMMIT / ROLLBACK

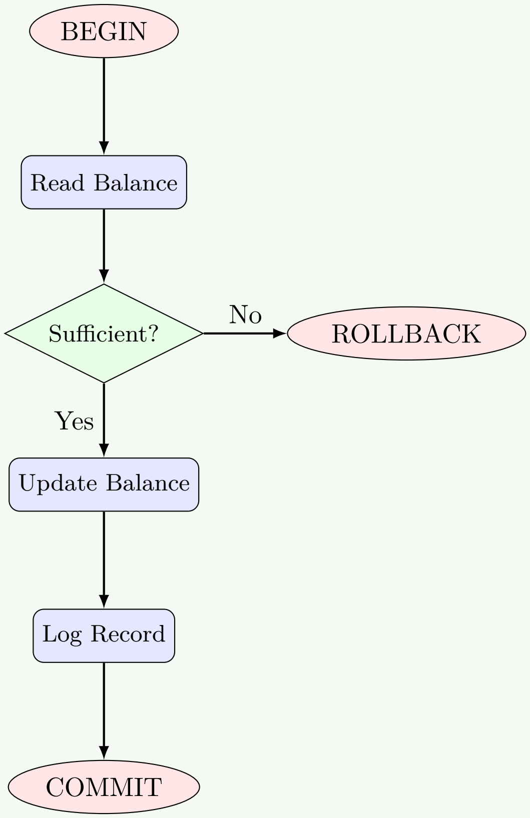


Figure 15. Transaction Life Cycle

```sql
BEGIN TRANSACTION;
UPDATE accounts SET balance = balance - 1000 WHERE acc_no = 123;
UPDATE accounts SET balance = balance + 1000 WHERE acc_no = 456;
COMMIT;
```

Mnemonic

Mnemonic: ”BEC: Begin, Execute, Commit”

OR

Question 5(b) [4 marks]

Explain equi-join with syntax and example.

Solution

Equi-join: A join operation that uses equality comparison operator.

Table 26. Equi-join

Feature	Description
Syntax	`SELECT * FROM t1, t2 WHERE t1.c = t2.c;`
Condition	Uses = operator
Columns	Includes columns from both tables

```sql
SELECT name, course_name
FROM students s, courses c
WHERE s.course_id = c.course_id;
```

Mnemonic

Mnemonic: ”EJE: Equi Join Equation (=)”

OR

Question 5(c) [7 marks]

Explain View Serializability in detail.

Solution

View Serializability: A schedule is view serializable if it is view equivalent to some serial schedule.

Table 27. View Equivalency Conditions

Condition	**Description**
Initial read	If T1 reads initial value of data item X in schedule S, it must also read initial value in schedule S'
Final write	If T1 performs final write of data item X in S, it must also perform final write in S'
Dependency preservation	If T1 reads value of X written by T2 in S, it must also read from T2 in S'

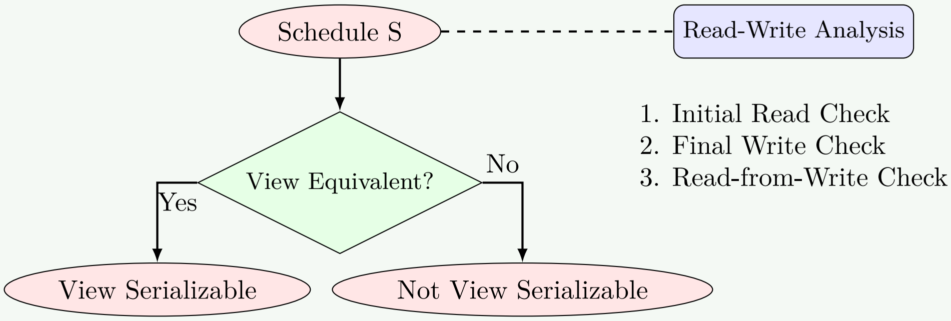


Figure 16. View Serializability Check

Comparison:
- **Conflict serializability**: More restrictive, easier to test (precedence graph)
- **View serializability**: More general, harder to test (NP-complete)

Example of view serializable but not conflict serializable:
- T1: W(X), T2: W(X), T3: R(X)
- Schedule: W1(X), W2(X), R3(X) is view equivalent to serial schedule T2,T1,T3

Mnemonic

Mnemonic: ”VIR-FF: View preserves Initial Reads and Final writes”