

Introduction to Database Management Systems

Introduction to Database Management Systems (DBMS)

Prepared as concise, easy-to-read study notes

1. What Is a DBMS?

Term	Definition
Database	A collection of logically related data stored for retrieval, update, and management.
DBMS	Software that provides systematic methods to create, store, query, and maintain databases. It acts as an interface between users/application programs and the physical data.
Key Idea: The DBMS abstracts the complexities of storage hardware, allowing users to focus on <i>what</i> data they need, not <i>how</i> it is stored.	

2. Core Functions of a DBMS

Function	Description	Typical SQL Commands
Data Definition	Define database schema (tables, indexes, constraints).	CREATE, ALTER, DROP
Data Manipulation	Insert, modify, delete, retrieve data.	INSERT, UPDATE, DELETE, SELECT
Security & Authorization	Control who can access/modify data.	GRANT, REVOKE
Transaction Management	Ensure atomicity, consistency, isolation, durability (ACID).	BEGIN TRANSACTION, COMMIT, ROLLBACK
Concurrency Control	Manage simultaneous accesses without conflicts.	Locking protocols, MVCC
Backup & Recovery	Protect data against loss/failure.	BACKUP, RESTORE, log-based recovery
Integrity Enforcement	Enforce rules that keep data correct.	Primary/foreign keys, CHECK constraints, triggers

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Function	Description	Typical SQL Commands
Query Optimization	Choose the most efficient execution plan.	Query planner, statistics, indexes

3. Data Models

Model	Characteristics	Example Use Cases
Hierarchical	Tree-like structure; each child has one parent.	XML storage, IBM IMS
Network	Graph structure; a child can have multiple parents.	Complex bill-of-materials, legacy systems
Relational	Data organized in tables (relations); uses set theory & predicate logic.	Most modern business applications
Object-Oriented	Stores objects with attributes & methods.	CAD/CAM, multimedia
Document / NoSQL	Stores semi-structured data (JSON, XML).	Content management, big data pipelines
Key-Value / Column-Family	Simple key-lookup or wide-column stores.	Caching, time-series data

The relational model remains the dominant paradigm for transactional systems.

4. Relational DBMS (RDBMS) Essentials

1. **Schema** – Logical design: tables, columns, data types, constraints.
2. **Tuple** – Row in a table (record).
3. **Attribute** – Column in a table (field).
4. **Primary Key** – Unique identifier for each tuple.
5. **Foreign Key** – References a primary key in another table; enforces referential integrity.
6. **Normalization** – Process of organizing tables to reduce redundancy and improve integrity (1NF, 2NF, 3NF, BCNF, etc.).

SQL (Structured Query Language) is the standard language for defining and manipulating relational data.

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5. Transactions & ACID Properties

Systems

Property	Meaning
Atomicity	All operations of a transaction succeed or none do (all?or?nothing).
Consistency	Transaction brings the database from one valid state to another, preserving all constraints