📊Master Roadmap — Database Systems (End-to-End)

This roadmap shows **all 22 phases**, their **dependencies**, and the **progression from foundations → internals → distributed → analytics → emerging technologies**.

🧱Level 1 — Foundations (Must-learn Basics)

```
Phase 1   → Foundations of Databases
Phase 2   → Data Modeling & ERD
Phase 3   → Relational Model & Constraints
Phase 4   → Relational Algebra
Phase 4.5→ Data Types & Storage Formats
```

⬇️*These phases build conceptual correctness before SQL or performance topics.*

🧪Level 2 — Core SQL & Data Quality

```
Phase 5   → SQL Basics
Phase 6   → Intermediate SQL
Phase 7   → Normalization Theory
```

⬇️*You now understand how to design clean schemas and write correct queries.*

⚙️Level 3 — Performance & Internals

```
Phase 8   → Indexing & Query Optimization
Phase 9   → Transactions, Concurrency & Locking
Phase 10 → Storage Engines & DB Architecture
```

⬇️*This level explains HOW databases actually work internally.*

🧰Level 4 — Server-side Logic & Security

```
Phase 11 → Stored Procedures, Triggers & Cursors
Phase 12 → Database Security
```

⬇️*Enterprise-grade database usage and protection.*

🩲Level 5 — Non-Relational & Scalability

```
Phase 13 → NoSQL & Modern Data Systems
Phase 14 → High Availability & Replication
```

⬇️*Beyond single-node relational databases.*

📈Level 6 — Analytics & Decision Systems

```
Phase 15 → Data Warehousing & OLAP
```

⬇️*Databases for reporting, BI, and analytics.*

⛏️Level 7 — Recovery & Fault Tolerance

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Phase 16 → Database Recovery Techniques
```

⬇️*Guaranteeing durability and crash recovery.*

🕐Level 8 — Distributed Databases

```
Phase 17 → Distributed Databases & Client-Server Architecture
```

⬇️*Coordination, distribution, and multi-node systems.*

🧬Level 9 — Extended & Object-Oriented Databases

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Phase 18 → Object-Relational & Extended-Relational Systems
Phase 19 → Object Database Standards & Design
```

⬇️*Extending relational systems with complex data & objects.*

🩲Level 10 — Semi-Structured & Web Data

```
Phase 20 → XML & Internet Databases
```

⬇️*Bridges traditional DBs with web and semi-structured data.*

🪥Level 11 — Analytics & Knowledge Discovery

```
Phase 21 → Data Mining Concepts
```

⬇️*Extracting knowledge from large datasets.*

🗜️Level 12 — Modern & Emerging Technologies

```
Phase 22 → Emerging Database Technologies & Applications
```

Includes: - Mobile databases - GIS & multimedia databases - GraphQL & federated data access - Data Lake & Lakehouse - Cloud databases (RDS, Aurora) - Global distributed SQL (Spanner)

🔦Dependency Summary (High-level Flow)

```
Foundations
   ↓
Modeling & Theory
   ↓
SQL & Normalization
   ↓
Performance & Internals
```

```
    ↓
Security & Server Logic
    ↓
NoSQL & Scalability
    ↓
Analytics & Warehousing
    ↓
Recovery & Distribution
    ↓
Object / Semi-Structured Data
    ↓
Mining, Cloud & Emerging Systems
```

🎓Final Outcome

By completing all **22 phases**, a learner can: - Design correct and scalable schemas - Optimize and debug slow queries - Understand DB internals (storage, indexing, recovery) - Build secure, transactional systems - Scale databases across machines and regions - Work with NoSQL, cloud, lakehouse, and modern data platforms

➡️ This roadmap aligns with **CS-grade DBMS theory**, **enterprise databases**, and **modern cloud data engineering**.