

Table of Contents

Author Biography	iii
Introduction	v
Chapter 1: Introduction to DBMS	1
1.1 Introduction.....	1
1.2 Data versus Information	2
1.3 Record.....	3
1.4 The File System.....	3
Limitations of File-Based System	4
1.5 The Evolution of Database	5
1.6 Defining a Database.....	7
1.7 Entities and Relationships	8
1.8 Data Models	9
1.9 Database Design	9
1.10 Types of Databases	10
Distributed Database	10
Object-Oriented Database.....	11
Temporal Database.....	12
Multimedia Database	12
Deductive Database	13
Semantic Database	13
Mobile Database.....	13
1.11 Transaction Management.....	14
Database Recovery and Security	15
1.12 Introduction to SQL.....	16
Defining SQL	16
Data Definition Language	17
Data Manipulation Language	19
Summary.....	27
Exercise.....	28
Multiple Choice Questions	28
Subjective Questions.....	30

Chapter 2: Advanced SQL	31
2.1 Introduction.....	31
2.2 Constraints.....	32
SQL NOT NULL Constraint.....	32
SQL UNIQUE Constraint.....	33
SQL PRIMARY KEY Constraint.....	33
SQL Foreign Key Constraint.....	33
SQL CHECK Constraint.....	34
SQL DEFAULT Constraint.....	34
2.3 SQL CREATE INDEX.....	35
Creation of Indexes.....	35
Dropping an Index.....	35
2.4 SQL Functions.....	36
SQL Aggregate Functions.....	36
2.5 The GROUP BY Statement.....	41
2.6 The HAVING Clause.....	43
2.7 SQL Special Functions.....	44
2.8 SQL Alias.....	51
2.9 SQL Join.....	51
SQL Inner Join.....	54
SQL Natural Join.....	56
SQL Equi Join.....	57
SQL Cross Join.....	58
SQL Left Outer Join.....	59
SQL Right Outer Join.....	60
SQL Full Outer Join.....	62
The SQL UNION Operator.....	63
2.10 Sub-Queries.....	65
2.11 Recursive Queries.....	66
2.12 Data Control Language.....	66
SQL GRANT Command.....	67
SQL REVOKE Command.....	67
Privileges and Roles.....	68
Creating and Dropping Roles.....	69
2.13 Views and Assertion.....	70
Views.....	70
Assertion.....	71

2.14	PL/SQL – A Basic Introduction.....	72
	Need for PL/SQL	72
	PL/SQL Code Structure.....	72
2.15	Triggers.....	74
	Types of PL/SQL Triggers.....	76
	Delete Trigger	77
2.16	Event Condition Action (ECA) Model	77
2.17	Functions and Procedures.....	77
	Statements in Procedures	78
	Procedures.....	78
	Executing a Stored Procedure.....	79
	PL/SQL Compilation Errors	80
	PL/SQL Compilation Errors Executing SHOW ERRORS.....	80
	Dependencies and Procedures	81
	Uses of Procedures.....	81
	Functions.....	81
2.18	Embedded SQL and Dynamic SQL.....	82
2.19	The JAVA Way to Access RDBMS: JDBC	85
	JDBC Drivers and Connections.....	85
	Creating JDBC Statements	86
	Creating JDBC PreparedStatement.....	87
	JDBC Query and Retrieving Answers.....	87
	JDBC Update.....	88
	Transaction and Connections.....	88
2.20	SQLJ	89
	SQLJ and Java.....	89
	Embedded SQLJ	89
	SQLJ Translator.....	89
	SQLJ Runtime Environment.....	90
	SQLJ Profiles.....	90
	Developing Applications Using SQLJ.....	90
	Benefits of SQLJ	90
	Codes	91
	Summary.....	94
	Exercise.....	94
	Multiple-Choice Questions.....	94
	Subjective Questions.....	96

Chapter 3: Advanced Transaction Processing and Recovery	97
3.1 Introduction.....	97
3.2 Defining a Transaction in DBMS	98
ACID Property	99
State of Transaction.....	100
3.3 Defining a Concurrent Transaction in DBMS.....	100
Schedule in Transaction	101
Problems in Concurrent Transaction	103
3.4 Serializability and Recoverability	106
Defining Serializability	106
Conflict Serializability	108
View Serializability	110
Precedence Graph and Serializability	110
Defining Recoverability.....	112
Cascading Rollback.....	113
3.5 Enhanced Lock-Based and Timestamp-Based Protocols	114
Lock-Based Protocol.....	114
Two-Phase Locking Protocol	117
Timestamp-Based Protocol.....	120
Defining Timestamp.....	120
3.6 Multiple Granularity.....	122
Multiple-Granularity Locking Protocol	123
3.7 Multi-Version Schemes	126
Multi-Version Timestamp-Based Protocol.....	126
Multi-Version 2PL Protocol.....	127
3.8 Optimistic Concurrency Control Techniques	128
3.9 Deadlock Handling	130
Causes of Deadlock.....	131
Deadlock Prevention	132
Deadlock Detection.....	133
3.10 Recovery in DBMS.....	135
Recoverability.....	135
Types of Failure.....	136
Methods to Control Failures	136
Different Techniques of Recoverability.....	137
3.11 Write-Ahead Logging Protocol.....	142

3.12	Advanced Recovery Techniques	142
	Shadow Paging.....	142
	Fuzzy Checkpoints.....	143
	ARIES.....	144
3.13	Use of SQL in Recovery	145
3.14	RAID	147
	RAID 0.....	147
	RAID 1.....	148
	RAID 3.....	149
	RAID 4.....	150
	RAID 5.....	150
	RAID 6.....	151
	Summary.....	152
	Exercise.....	152
	Multiple Choice Questions	152
	Subjective Questions.....	154
Chapter 4: Data Security		155
4.1	Introduction.....	155
4.2	Introduction to Data Security Issues	155
	Excessive Privilege Abuse.....	156
	Legitimate Privilege Abuse	157
	Privilege Elevation	157
	Database Platform Vulnerabilities.....	157
	SQL Injection.....	157
	Weak Audit Trail.....	157
	Denial of Service	157
	Database Communication Protocol Vulnerabilities	158
	Weak Authentication.....	158
	Backup Data Exposure.....	158
4.3	Discretionary Access Control.....	158
	Request Modification	160
4.4	Mandatory Access Control	160
	Bell-La Padula Model.....	161
	Multilevel Secure Database Management Systems.....	162
4.5	Role-Based Access Control.....	162
4.6	SQL Injection.....	163

	SQL Manipulation	163
	Code Injection	164
	Function Call Injection.....	164
4.7	Statistical Databases	165
	Security in Statistical Databases	165
4.8	Introduction to Flow Control.....	165
	Summary.....	166
	Exercise.....	166
	Multiple Choice Questions.....	166
	Subjective Questions.....	168
 Chapter 5: Storage and Indexing		169
5.1	Introduction.....	169
5.2	Basics of Database Storage.....	169
	Records and Record Types	170
	File Organization.....	170
5.3	Operations on Files.....	170
5.4	Hashing Techniques	172
	Internal Hashing.....	173
	External Hashing.....	174
	Hashing for Dynamic File Expansion	174
5.5	File Indexing	175
5.6	Types of Single-Level Ordered Indexes	176
	Primary Indexes.....	176
	Clustering Indexes	178
	Secondary Indexes	179
5.7	Multi-Level Indexes.....	180
5.8	Dynamic Multi-Level Indexes	181
	Difference between B-tree and B+-tree.....	181
	B-Tree Structure.....	181
	B+-Tree Structure.....	182
	Insertion in a B+-Tree	183
	Deletion from a B+-Tree.....	183
5.9	Indexing on Multiple Keys	185
	Summary.....	186

Exercise.....	186
Multiple Choice Questions.....	186
Subjective Questions.....	188
Chapter 6: Distributed Databases	189
6.1 Introduction.....	189
6.2 Differences between Centralized DBMS and Distributed DBMS	190
6.3 Functionality of DDBMS.....	191
6.4 Advantages and Disadvantages of DDBMS	191
6.5 Centralized versus Non-Centralized Databases.....	192
6.6 Homogeneous and Heterogeneous DDBMS and Their Comparison.....	193
6.7 Architecture of DDBMS.....	194
Client-Server DDBMS Architecture	194
Peer-to-Peer Architecture.....	196
6.8 Distributed Data Storage	197
Replication of Data	197
Fragmentation of Data	197
Hybridization (Combination of Both Replication and Fragmentation) of Data	201
6.9 Transparency Issue in DDBMS.....	201
Network Transparency.....	202
Replication Transparency	202
Fragmentation Transparency	202
6.10 Distributed Database Design and Query Processing in DDBMS	203
6.11 Distributed Transaction Management	205
6.12 Distributed Commit Protocols: 2PC and 3PC.....	206
Two-Phase Commit Protocol	207
Three-Phase Commit Protocol	208
Difference between 2PC and 3PC.....	209
6.13 Distributed Concurrency Control.....	210
Single-Lock Manager Approach.....	210
Distributed Lock Manager Approach.....	211
6.14 Distributed Deadlock Management	212
Distributed Deadlock Detection	213
Distributed Deadlock Prevention.....	215
6.15 Concepts of Replication Servers.....	215

Summary.....	216
Exercise.....	216
Multiple Choice Questions.....	216
Subjective Questions.....	218
Chapter 7: Object Database	219
7.1 Introduction.....	219
7.2 Overview of the Object-Oriented Database.....	220
7.3 Limitations of Relational Database.....	223
7.4 Need for Complex Data Type	226
Collection and Large Object Types.....	226
7.5 Collection Types and Structured Types.....	228
7.6 Data Definition	229
Objects	229
Object Classes	229
Abstraction	229
Inheritance.....	230
7.7 Object Identity and Reference Types	234
Object Identifiers	234
Object Containment.....	234
Defining a Schema	235
7.8 Persistent Programming Languages	236
Persistence of Objects.....	237
7.9 Object – Relational Database	237
Performance Constraints.....	238
ORDBMS Benefits.....	238
Object-Relational DBMS Applications.....	240
ORDBMS Concepts and Terminology.....	241
7.10 Object Database Extensions to SQL	241
7.11 Object Definition Language	244
Abstraction	245
Encapsulation	245
Inheritance.....	245
7.12 Object Query Language.....	245
Query Input and Result.....	246

Summary.....	246
Exercise.....	246
Multiple Choice Questions.....	246
Subjective Questions.....	248
Chapter 8: Introduction to Data Warehousing.....	249
8.1 Introduction.....	249
8.2 The Need for Data Warehousing.....	250
8.3 Data Warehousing: An Information Environment.....	250
Benefits of Data Warehousing.....	251
Features of Data Warehouse.....	251
8.4 Increased Demand for Strategic Information.....	252
8.5 Inability of Past Decision Support System.....	253
8.6 Operational vs. Decisional Support System.....	254
8.7 Information Flow Mechanism.....	255
Key Components.....	256
8.8 Classification of Metadata.....	256
8.9 Data Warehouse and Data Marts.....	256
8.10 Data Warehouse Architecture.....	258
8.11 Different Types of Architecture.....	259
Data Consistency Architecture.....	259
Reporting Data Store and Staging Data Store Architecture.....	260
Data Modeling Architecture.....	260
Tool Architecture.....	260
Processing Tiers Architecture.....	260
Security Architecture.....	260
8.12 Data Warehouse Design Techniques.....	260
Bottom-up Design.....	260
Top-down Design.....	261
Summary.....	261
Exercise.....	262
Multiple Choice Questions.....	262
Subjective Questions.....	264

Chapter 9: Introduction to Dimensional Modeling.....	265
9.1 Introduction.....	265
9.2 Data Warehouse Modeling vs. Operational Database Modeling.....	266
9.3 Dimensional Model vs. the ER Model.....	267
9.4 Features of a Good Dimensional Model	268
9.5 Introducing the Fact Table	269
9.6 Introducing the Dimension Table.....	269
9.7 The Factless Face Table	270
Factless Fact Tables for Events.....	271
Factless Fact Tables for Conditions	271
9.8 The Star Schema	271
Query Execution in Star Schema	272
9.9 Snowflake Schema.....	273
9.10 Updates to Dimension Tables	274
9.11 Slowly Changing Dimensions	275
Slowly Changing Dimension Type 1.....	275
Slowly Changing Dimension Type 2.....	275
Slowly Changing Dimension Type 3.....	275
9.12 Large Dimension Tables.....	276
9.13 Rapidly Changing or Large Slowly Changing Dimensions	277
9.14 Junk Dimensions.....	278
9.15 Keys in the Data Warehouse Schema	278
Primary Key	279
Surrogate Key	279
Foreign Keys	281
9.16 Aggregate Table.....	281
9.17 Fact Constellation Schema or Family of Stars.....	282
Summary.....	282
Exercise.....	283
Multiple Choice Questions	283
Subjective Questions.....	284
 Chapter 10: ETL Process.....	 285
10.1 Introduction.....	285
10.2 Overview of the ETL Process.....	286

10.3	Need for the ETL Process	286
10.4	Data Extraction	287
10.5	Identification of Data Source	287
10.6	Extraction Methods in Data Warehouse	288
	Logical Extraction Methods	289
	Physical Extraction Methods	291
10.7	Change Data Capture	292
10.8	Transportation in Data Warehouses	294
	Transportation Mechanisms in Data Warehouses	294
10.9	Transformation	295
	Transformation Flow	295
	Transformation Mechanisms	297
10.10	Staging	300
10.11	Loading	301
	Loading a Data Warehouse with SQL*Loader	301
	Loading a Data Warehouse with External Tables	302
	Loading Data Warehouse with OCI and Direct-Path APIs	303
	Loading Data Warehouse with Export/Import	303
10.12	Fact Tables	303
	Aggregation in Fact Tables	303
10.13	Dimension Tables	304
	Surrogate Keys	305
	Referential Integrity	305
	Shared Dimensions	306
10.14	Cleaning	306
	Need for Data Cleaning and Transformation	306
10.15	Tools for ETL	307
	ETL Tools for Data Warehouses	307
	Daily Operations in Data Warehouses	308
	Evolution of the Data Warehouse	308
	Summary	308
	Exercise	308
	Multiple Choice Questions	308
	Subjective Questions	310

Chapter 11: Online Analytical Processing (OLAP)	311
11.1 Introduction.....	311
11.2 Introduction to OLAP.....	311
11.3 Need for OLAP	312
11.4 OLAP Models	312
11.5 OLTP Vs OLAP	313
11.6 Multidimensional Analysis or Data Cube	314
11.7 On-Line Analytical Processing (OLAP)	317
Summary	318
Exercises	318
Multiple Choice Questions	318
Subjective Questions.....	320
ADBMS Lab Implementation	321
Index	331