Program Content

Semester	**II**		
Course Code:	**IT2306**		
Course Name:	**Database Systems I**		
Credit Value:	**04**		
Core/Optional	**Core**		
Hourly Breakdown	Theory	Practical	Independent Learning
	45	30	125

Course Aim/Intended Learning Outcomes:

On completion of this course, students should be able to design and develop a database using a commercial database product eliminating anomalies and applying fundamentals and concepts of database management systems.

At the completion of this course student will be able to:

- Describe the role of a database management system the three-schema architecture and the difference between conceptual, external and physical schemas.
- Demonstrate how organizational data can be modeled to produce conceptual schema by using ER data modeling concepts to cater for the data requirements of that organization.
- Convert conceptual model into relational schema.
- List the operations of relational algebra and show how they can be used to create new relations from existing relations.
- Formulate SQL queries of varying complexity.
- Describe view concept and discretionary access control as security mechanisms of database systems.
- Demonstrate how relations can be normalized upto 3rd normal form.

Course Content: (Main Topics, Sub topics)

Topic	Theory (Hrs)	Practical (Hrs.)
1. Introduction to DBMS	04	-
2. Relational Data Model	03	01
3. Database design process	10	05
4. Relational Algebra	04	04
5. Data Manipulation using SQL	13	10
6. Data Security	07	05
7. Data normalization process and the normal forms	04	05
Total	45	30

1. Introduction to DBMS

1.1 The Evolution of Database Technology

1.1.1. Data, information, database, database system, database management system; Data processing and data management, Increasing use of data as a corporate resource. **[Ref 1: Pg. (3-9)]**

1.1.2. File oriented systems: Meeting the need for random access processing; Limitations of Traditional File Systems: Data redundancy, Inadequate data manipulation capabilities, program-data dependency; Data independence. **[Ref 1: Pg. (10-27)**

1.2 Database Architecture

1.2.1. Components of a Database Management System (DBMS): Data Dictionary (importance, contents), meta data; Data security and integrity; Concurrent access; User-oriented data query and reporting; Application development facilities **[Ref 1: Pg. (31-35)]**

1.2.2. Database Systems; ANSI/SPARC Three-level Architecture: Conceptual model, Logical model, Physical model, External view, Conceptual view, Internal view of data. [Ref 1: pg.36-38]

1.2.3. Data specification and access mechanisms: Data Definition Language (DDL), Sub-Schema DDL, Data Manipulation Language (DML); Users: End users, Database Administrator (DBA); DBMS: Functions, Capabilities, Advantages and disadvantages. **[Ref 1: Pg. (15-23), (39-40)]**

1.3. Users of a Database

1.3.1. Users and practitioners of a Database System **[Ref 1: Pg. (15-17)]**

1.3.2. Data administrator, Database Administrator (DBA), Functions of a DBA. **[Ref 1: Pg. (15)]**

1.3.3. Roles of a DBA with respect to Database Integrity, Transaction Processing, Concurrency Control, Database Security and Database Recovery. **[Ref 1: Pg. (17-22)]**

2. Relational Data Model

2.1 Introduction Data Models: Review of database models, Definition of Relation, Attribute, tuple, domain, instance, cardinality, degree, schema, Constrains. **[Ref 1: Pg. (59-79)]**

2.2 Concepts of keys: Candidate key, Primary key, Alternate key, Composite key, Surrogate key, Foreign key. **[Ref 1: Pg.(67-69), (159-160), (163-165), (174,187) , (476-477), (631)]**

2.3 Fundamental integrity rules: entity integrity, referential integrity: Domain constraints, Key constraints. **[Ref 1: Pg. (21), (158-160), (163-165), (186-187)]**

3. Database design process

3.1. Conceptual Design through Entity-Relationship (ER) Modeling

3.1.1. The Role of ER Diagrams. **[Ref 1: Pg. (107-108)]** Three classes of objects: Entities, Relationships and Attributes. **[Ref 1: Pg. (63-64)]** Entities: Entity, Entity instance, Subtype and Super-type Entities, Strong and weak entities**. [Ref 1: Pg. (79), (108-110), (292-293)]**

3.1.2. Attributes: Identifying attributes, Attribute types (identifier, descriptor), Derived data, Domain, Composite attributes. **[Ref 1: Pg. (65-67), (441)]**

3.1.3. Relationships: Connectivity (binary, n-array), (1:1, 1:N, M:N), Determining the connectivity, Cardinality, Existence dependency (mandatory, optional). **[Ref 1: Pg. (72-77), (153)]**

3.1.4. EER Modeling: Generalization, specialization, constraints on generalization and specialization, Category entity type. **[Ref 1: Pg. (67-70), (107-113)]**

3.2. Logical Design through Mapping

3.2.1. Mapping regular, weak, generalized and specialized entities, Relationship types, Multi- valued attributes. **[Ref 1: Pg. (79) ,(212-220), (213-222)]**

3.2.2. Resolve the conceptual data model; Redundant Relationships; Recursive Relationships; Resolving Relationships: 1:1, M:N. **[Ref 1: Pg. (33), (60-62), (75), (223)].**

4. **Relational Algebra**

4.1. Relational algebra (RA) Operations: Traditional Set Operations (Union, Intersection, Difference, Cartesian Product) **[Ref 1: Pg.(239-251)]**

4.2. Special Relational Operations: Select or Restrict, Project, Join, Different types of join (theta join, equi-join, natural join, outer joins), Division, Minimal set of operations, Simple and Complex queries using RA. **[Ref 1: Pg.(251-288)]**

5. **Data Manipulation using SQL**

5.1 Structured Query Language (SQL): Introduction to SQL standards: SQL86, SQL89 and SQL92. **[Ref 1: Pg. (177-180)]**

5.2 Data types

5.2.1 Categories of Data Types: Character, Numeric, Variable Character, Date, Serial, Money, Date-time, Interval. **[Ref 1: Pg. (182-184)].**

5.2.2 Character: CHARACTER (CHAR); Numeric: INTEGER (INT), SMALLINT, FLOAT, SMALLFLOAT, DECIMAL; Variable Character: CHARACTER VARYING (VARCHAR); Binary Large Object (BLOB): Text, Byte. **[Ref 1: Pg. (182-184)].**

5.3 Creating SQL Tables

5.3.1 Defining tables: CREATE TABLE, ALTER TABLE, DROP TABLE. **[Ref 1: Pg. (180-182)].**

5.3.2 Specifying integrity constraints: PRIMARY KEY, UNIQUE, NOT NULL, CHECK, Referential Integrity constraints (Cyclic, Self-referencing, Multiple path) FOREIGN KEY (CASCADE, RESTRICT, NULL, DEFAULT.) **[Ref 1: Pg. (184-187), (203-206), (233-234)]**

5.3.3 Creating indexes: CREATE INDEX, DROP INDEX. **[Ref 1: Pg. (45), (202), (235), (637-639)]**

5.4 Selecting Data

5.4.1 Queries: SELECT Statement. **[Ref 1: Pg.(187-206)**]

5.4.2 Single Table: all columns (*), selecting specific columns (RA project operation), unique values (DISTINCT), Executing multiple statements (;), WHERE clause (RA select operation), Including or excluding rows (=, !=), Relational Operators (=, !=, >, >=, <, <=), Identifying Null values (IS NULL), Where clause keywords (AND, OR, [NOT] BETWEEN, [NOT] IN, IS [NOT] NULL, [NOT] LIKE, ORDER BY) Arithmetic Operators (+, -, *, /), Expressions, Display Labels, Aggregate Functions: (COUNT, SUM, AVG, MAX, MIN, GROUP BY, HAVING.) **[Ref 1: Pg.(187-206), (196-197), (216-240), (260-268)]**

5.4.3 Multiple Table: RA join and product operations, Natural Join, Multiple Table Joins, Aliases for table names, Outer Join, UNION. **[Ref 1: Pg.(215-216), (246-251)]**

5.4.4 Functions: Arithmetic (ROUND, TRUNC), String (TO_CHAR, UPPER, LOWER, Sub strings, Concatenation, TRIM), Date and Time (DAY, MONTH, YEAR, DATE, CURRENT). **[Ref 1: Pg. (65), (182-183), (195-197)]**

5.4.5 Sub queries: Nested Select Statement, Values returned by sub queries (single value, a list of values), EXISTS, Correlated nested queries. **[Ref 1: Pg.(197), (209- 215)]**

5.5 Data Insertion, Updating and Deletion

5.5.1 Inserting Data: INSERT INTO [VALUES|SELECT] including a column list, null values; obtaining values from a SELECT. **[Ref 1: Pg. (198-201)]**

5.5.2 Updating Data: UPDATE (selected columns, selected rows, with a sub query). **[Ref 1: Pg. (198-201)]**

5.5.3 Deleting Data: DELETE (all data, selected data, with a sub query). **[Ref 1: Pg. (198-201)]**

6. Data Security

6.1. Types of Security and Threats to Database Systems [Ref 1: Pg. (1121-1123)]

6.2. Data Views

6.2.1. What is a view? **[Ref 1: Pg. (228-229)]**

6.2.2. Views using SQL: Creating view (CREATE VIEW), Dropping view (DROP VIEW), View Updatability and WITH CHECK OPTION in SQL **[Ref 1: Pg.(229-235)]**

6.3. Discretionary Access Control

6.3.1. Types of Discretionary Privileges **[Ref 1: Pg.(1129-1130)]**

6.3.1.1. System Privileges

6.3.1.2. Object Privileges

6.3.2. Granting and Revoking Privileges **[Ref 1: Pg.(1129-1130)]**

6.3.3. Propagation of Privileges **[Ref 1: Pg.(1133-1134)]**

7. **Data normalization process and the normal forms**

7.1 Introduction to data normalization and normal forms [Ref 1: Pg. (459-477)]

7.1.1 What is normalization, Benefits of normalization, Normalization Rules

7.1.2 1NF, 2NF, 3NF and Higher NF.

7.2 First Normal Form [**Ref 1: Pg.(477-481), (483-484)]**

7.2.1 1NF, Why convert to 1NF, Conversion to 1NF;

7.3 Second Normal Form [Ref 1: Pg. (481-482), (484-486)]

7.3.1 2NF, Functional Dependence and Fully Functional Dependence, Why convert to 2NF, Conversion to 2NF

7.4. Third Normal Form [Ref 1: Pg. (483-484) , (486-487)]

7.4.1. 3NF, Transitive Dependence, Why convert to 3NF, Conversion to 3NF.

7.5. Normalization considerations [Ref 1: Pg. (491-496)]

Teaching /Learning Methods:

You can access all learning materials and this syllabus in the VLE: http://vle.bit.lk/, if you are a registered student of the BIT degree program. It is important to participate in learning activities given in the VLE to learn this course.

Assessment Strategy:

Continuous Assessments/Assignments:

The assignments consist of two quizzes, assignment quiz 1 (It covers the first half of the syllabus) and assignment quiz 2 (It covers the second half of the syllabus). The maximum mark for a question is 10 and the minimum mark for a question is 0 (irrespective of negative scores). Final assignment mark is calculated considering both assignments, and students will have to obtain at least 40% for each assignment. Students are advised to complete online assignments before the given deadline. It is compulsory to pass all online assignments to qualify to obtain the Level I, Diploma in IT (DIT), certificate.

In the course, case studies/Lab sheets will be introduced, and students have to participate in the learning activities.

Final Exam:

The final examination of the course will be held at the end of the semester. The paper consists of 40 MCQs and candidates have to answer all the 40 questions within 2 hours.

References/ Reading Materials:

Main Reading:

Ref 1. Fundamentals of Database Systems by R. Elmasri and S.B. Navathe, 7th edition, Addison-Wesley, 2015.

Supplementary Reading:

Ref 2. Database Management Systems by R. Ramakrishnan and JGehrke, 3rd edition, McGraw-Hill, International Edition, 2003.

Ref 3. Database Systems by Thomas M. Connolly Connolly E.Begg, 4th edition, Low Price Edition, 2005.

Ref 4. Database System Concepts by A. Silberschatz, H.F. Korth and S. Sudarshan, 7th edition, McGraw-Hill, International Edition, 2019.

Ref 5. An Introduction to Database Systems by C.J. Date, 8th edition, Addison-Wesley, Low Priced Edition, 2003.

Ref 6. Modern Database Management by R.F. McFadden and J.A. Hoffer,11th edition, Benjamin-Cummins, 2012.

Ref 7. A Guide to the SQL Standard , C.J. Date and H. Darwen, 4th edition, Reading, MA: Addison-Wesley, 1996.