Title (Units): **COMP7640 Database Systems and Administration (3,3,0)**

Course Aims: To give students a solid background in relational DBMS. To learn general DBMS designs and internals, including relational data modeling, relational database design, data storage, index structures, query evaluation, transaction processing, concurrency control, and crash recovery. To discuss advanced topics such as distributed databases and data warehouses.

Prerequisite: Nil

Course Intended Learning Outcomes (CILOs):
Upon successful completion of this course, students should be able to:

No.	Course Intended Learning Outcomes (CILOs)
	Knowledge
1	Explain the basic concepts of RDBMS design, including entity-relationship model, relational data model and data normalization
2	Explain database languages: relational algebra and SQL
3	Explain underlying disk-based data storage, organization and access methods in RDBMS
4	Explain query evaluation, query optimization, concurrency control and crash recovery techniques
	Professional Skill
5	Analyze the tradeoffs of alternative database designs and implementation mechanisms
	Attitude
6	Develop team spirit and professional attitude towards database management and administration

Calendar Description: This course is to provide an in-depth knowledge of relational database management systems (RDBMS). Topics include: conceptual modeling of a database, relational data model, relational algebra, database language SQL, relational database design, data storage, index structures, external sorting, query evaluation, transaction processing, concurrency control, and crash recovery. In addition, advanced topics such as data lake, graph databases and distributed databases will also be covered. The students will have a thorough understanding of RDBMS after taking this course.

Teaching and Learning Activities (TLAs):

CILOs	Type of TLA
1-4	Students will learn the database management concepts and methods via lectures, tutorials, and assignments.
5	Students will investigate alternative database designs and implementation techniques.
1-6	Students will work on a project to gain hands-on experience.

Assessment:

No.	Assessment Methods	Weighting	CILOs to be addressed	Description of Assessment Tasks
1	Continuous Assessment	40%	1-6	It may include written assignments and project reports. The course instructors can design the most appropriate forms of assessment to complement their teaching and learning strategies and determine their weighting.
2	Examination	60%	1-5	Final Examination questions are designed to evaluate how far students have achieved their intended learning outcomes. Questions will primarily be analysis and skills based to assess the students' ability in design and management of database systems.

Assessment Rubrics:

Excellent (A)	• Achieve the first five CILOs, demonstrating a good mastery of both the theoretical and practical aspects of database design and administration • Have a thorough understanding of database system concepts, and be able to explain and highlight the key points of these concepts • Able to build ER diagrams according to all application requirements, convert ER diagrams to relational database schemas correctly, and eliminate all functional dependencies in a database schema via normalization • Able to create, populate, update a relational database in SQL language and formulate database queries in both relational algebra and SQL • Able to draw on a variety of relevant knowledge and concepts and apply them to analyze the tradeoffs of database design and implementation alternatives with detailed explanations
Good (B)	• Achieve the first five CILOs, demonstrating a good understanding of both the theoretical and practical aspects of database design and administration • Have a good understanding of database system concepts • Able to build ER diagrams according to most of the application requirements, convert ER diagrams to relational database schemas most correctly, and eliminate most of the functional dependencies in a database schema via normalization • Able to create, populate, update a relational database in SQL language and formulate database queries in both relational algebra and SQL for most cases • Able to make use of relevant knowledge and concepts and apply them to analyze the tradeoffs of database design and implementation alternatives with sound explanations
Satisfactory (C)	• Achieve most of the first five CILOs, demonstrating a basic level of understanding of the theoretical and practical aspects of database design and administration • Have a basic understanding of database system concepts • Able to build ER diagrams according to some database application requirements, convert some ER diagrams to relational database schemas, and eliminate some functional dependencies in a database schema via normalization • Able to create, populate, update a relational database in SQL language and formulate database queries in both relational algebra and SQL for familiar cases • Able to make use of some relevant knowledge and concepts and apply them to analyze the tradeoffs of some database design and implementation alternatives
Fail (F)	• Achieve less than three of the CILOs, and have little understanding of the theoretical and practical aspects of database design and administration • Unable to provide solutions to simple problems which require basic understanding of database system concepts • Unable to conduct database designs using ER diagrams and functional dependency analysis • Have little understanding of relational algebra and SQL language and have difficulty in applying them to manipulate a database • Unable to analyze the tradeoffs of database design and implementation alternatives

Course Content and CILOs Mapping:

Content		**CILO No.**
I	The Entity-Relationship Data Model	1
II	The Relational Data Model and Database Language	1, 2
III	Relational Database Design	1, 5
IV	Disk and Memory Management	3, 5, 6
V	Access Methods and Indexing	3, 5, 6
VI	Query Evaluation and Optimization	4, 5, 6
VII	Concurrency Control and Crash Recovery	4, 5, 6
VIII	Advanced/Current Topics	5, 6

References:

- Raghu Ramakrishnan and Johannes Gehrke. Database Management Systems, 3rd Edition, McGraw Hill, 2003.
- Ramez Elmasri and Shamkant B. Navathe. Fundamentals of Database Systems, 7th Edition, Addison Wesley, 2015.
- Hector Garcia-Molina. Database Systems: The Complete Book, Prentice Hall, 2014.
- Abraham Silberschatz, Henry F. Korth, and S. Sudarshan. Database System Concepts, 7th Edition, McGraw Hill, 2019.
- Carlos Coronel and Steven Morris. Database Systems: Design, Implementation, & Management, 13th Edition, Course Technology, 2018.

Course Content:

Topic

I. The Entity-Relationship Data Model
   A. Elements of the ER model
   B. Conceptual design with the ER model
   C. Modeling of constraints

II. The Relational Data Model and Database Language
   A. Relational model concepts
   B. Relational database schemas
   C. Relational algebra
   D. SQL

III. Relational Database Design
   A. Functional dependencies
   B. Normal forms and normalization

IV. Disk and Memory Management
   A. Disk space management
   B. Buffer management
   C. File organization

V. Access Methods and Indexing
   A. Dynamic Tree-Structured indexing
   B. Hashing indexing

VI. Query Evaluation and Optimization
   A. Query operator evaluation
   B. Query optimization
   C. External sorting

VII. Concurrency Control and Crash Recovery
   A. Transactions
   B. Locking-based concurrency control
   C. Concurrency control without locking
   D. Crash recovery

VIII. Advanced/Current Topics