Course number and name: **CS 04430: Database Systems: Theory and Programming**

Credits and contact hours: 3 credits / 3 contact hours

Instructor’s or course coordinator’s name: Jack Myers


Specific course information

**Catalog description:** This course focuses on the design of DBMS and their use to create databases. The course covers both the theoretical concepts and the implementation aspects of database systems with a special emphasis on relational database systems, SQL, programming (in a modern programming language such as C++ or Java) using a real database Application Programming Interface (such as JDBC or ODBC)

**Prerequisites:** CS04222 Data Structures and Algorithms

**Type of Course:** ☒ Selected Elective

Specific goals for the course

Students should be able to:

- Define the terminology, features, classifications, and characteristics embodied in database systems.
- Analyze an information storage problem and derive an information model expressed in the form of an entity relation diagram and other optional analysis forms, such as a data dictionary.
- Demonstrate an understanding of the relational data model.
- Transform an information model into a relational database schema and to use a data definition language and/or utilities to implement the schema using a DBMS.
- Formulate, using SQL, solutions to a broad range of query and data update problems.
- Demonstrate an understanding of normalization theory and apply such knowledge to the normalization of a database.
- Use an SQL interface of a multi-user relational DBMS package to create, secure, populate, maintain, and query a database.
- Understand the value of NoSQL databases, and how to implement and query them
- Use a desktop database package to create, populate, maintain, and query a database.
- Demonstrate a rudimentary understanding of programmatic interfaces to a database and be able to use the basic functions of one such interface.
- Understand the basic issues of transaction processing and concurrency control.
- Understand database security implications
Required list of topics to be covered

- Overview of database types with advantages and disadvantages
- Data Modeling
- SQL DML (Data Manipulation Language)
- SQL DDL (Data Definition Language)
- Joins and unions
- Aggregation queries
- Subqueries
- Views
- Functional dependencies and normalization
- Database performance / indexes
- Database programming
  - Database level (triggers, procedures)
  - Client level (e.g., flask, PHP)
- User creation/deletion, permissions and access control
- Database security, vulnerabilities and protections e.g.,
  - Data protection techniques
  - SQL Injection
  - Inference attacks
  - Polyinstantiation
- NoSQL databases

Optional list of topics that could be covered:

- Relational algebra
- Object-Relational Mapping (ORM)
- Physical storage of database records
- Data Warehousing and OLAP tools