CSE 111 – DATABASE SYSTEMS

- Instructor: Florin Rusu (office: SE2-210; frusu@ucmerced.edu; http://faculty.ucmerced.edu/frusu)
- TAs: Chieh Lin (clin83@ucmerced.edu); Brian Tsan (btsan@ucmerced.edu)

Meeting time. The lectures are pre-recorded and posted online in CatCourses. The expectation is that students watch the recordings before the in-person lectures, which are held with two lab sessions at a time. This means that students who have lab on Tuesday have to attend only the Tuesday lecture and students who have lab on Thursday have to attend only the Thursday lecture. The same material is covered in both lectures. This method is approved by the Academic Senate.

- Lecture: T, R 10:30-11:45AM; COB2-140
- Lab: T 1:30-4:20PM, SCIENG-100 (Brian Tsan); T 4:30-7:20PM, SCIENG-100 (Chieh Lin); R 1:30-4:20PM, SCIENG-100 (Brian Tsan); R 4:30-7:20PM, SCIENG-138 (Chieh Lin)
- Instructor office hours: W 12-2PM or by appointment
- TAs office hours: M 10AM-12PM (Chieh Lin); F 2-4PM (Brian Tsan)

Remote lab access. The UC Merced School of Engineering provides remote access to the computer labs. These can be accessed at `https://mylab.ucmerced.edu/`. The required software for the class is installed on the lab machines. This includes the `sqlite` database, the `Python, Java, and C/C++` programming languages, the `SQLiteStudio` and `vscode` IDEs, and `git`. In addition to these local resources, students are encouraged to use the `GitHub` code repository, especially for their project.

Exams.

- Midterm: Wednesday, October 27 (24 hours, open books)
- Final: Saturday, December 11 (24 hours, open books)

Description. Principles of database design and operation. Data models, with emphasis on the relational data model. High-level data modeling languages. The theoretical foundations of query languages. SQL database language: data definition, data modification, and query. Constraints and active databases through triggers. Query optimization with views and indexes. Database servers and their exploit within programming languages and user interactions. Web-based applications with a database server as a back-end. Other topics include transaction processing, security in databases, user-defined types and user-defined functions, and data warehousing.

Prerequisites.

- CSE 031 – Computer Organization
- CSE 100 – Algorithm Design and Analysis

Textbook.

- Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom – *Database Systems, The Complete Book*, 2^{nd} Edition, 2009, Prentice Hall, ISBN: 978-0-13-815504-9.

References.

- Avi Silberschatz, Henry F. Korth, and S. Sudarshan – *Database System Concepts*, 6^{th} Edition, 2010, McGraw-Hill, ISBN: 0-07-352332-1.
- Raghu Ramakrishnan, Johannes Gehrke – *Database Management Systems*, 3^{rd} Edition, 2003, McGraw-Hill, ISBN: 0-07-246563-8.
- Ramez Elmasri, Shamkant B. Navathe – *Fundamentals of Database Systems*, 6^{th} Edition, 2011, Addison-Wesley, ISBN: 978-0-136-08620-8.

Topics.

1. The Relational Model of Data
   - Data models
   - Basics of the relational model: attributes, schemas, tuples, domains
   - SQL: relations, data types, constraints
   - Relational algebra
2. High-Level Database Models
   - Entity/Relationship (ER) Model
   - Unified Modeling Language (UML)
   - Object Definition Language (ODL)
3. The Database Language SQL
   - Queries
   - Subqueries
   - Aggregation and grouping
   - Insert/Delete/Update
   - Transactions
4. Constraints and Triggers
   - Keys and foreign keys
   - Constraints on attributes and tuples
   - Triggers
5. Views and Indexes
   - Virtual views
   - Indexes in SQL
   - Selection of indexes
   - Materialized views
6. SQL in a Server Environment
   - The Three-Tier architecture
   - The SQL environment and the SQL/host-language interface
   - Stored procedures

- JDBC and PHP

7. Advanced Topics in Relational Databases
    - Security and user authorization in SQL
    - Recursion in SQL
    - User-defined types in SQL
    - OLAP, data warehouses, and data cubes

Learning goals. The goal of this course is to expose students to databases and relational data management. At the end of the course, students will be able to:

- operate a relational database server by the use of the SQL language
- design a database schema using a high-level modeling language
- implement the schema inside a server, and access the data from a programming environment
- design and implement an application having a back-end database server
- manage a database server

This will be achieved by presenting the theoretical foundations of relational data management during the lectures and the practical experience students will gain during the lab sessions and through a semester-long project. In essence, the objective of this class is to make students capable of designing and implementing a web-based application having a back-end database server and to provide students enough knowledge to manage a database server.

Program learning outcomes. This course relates to the following program learning outcomes:

- (A) An ability to apply knowledge of computing and mathematics appropriate to the discipline
- (B) An ability to analyze a problem and identify the computing requirements appropriate for its solution; An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs, and use current techniques, skill, and tools necessary for computing practice
- (C) An ability to function effectively as a member of a team in order to accomplish a common goal
- (E) An ability to communicate effectively with a range of audiences
- (H) An ability to apply mathematical foundations, algorithmic principles, and computer science theory to the modeling and design of computer based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices

Academic integrity policy. Each student in this course is expected to abide by the UC Merced and the Computer Science and Engineering (CSE) Department Academic Honesty Policy. Any work submitted by a student in this course for academic credit will be the student's own work. Students are encouraged to study together and to discuss information and concepts covered in lectures. Students can provide/receive "consulting" to/from other students. However, the permissible cooperation should never involve one student having possession of a copy of all or part of the work done by someone else, in the form of an email, an email attachment file, a storage device, or a hard copy. Should copying occur, both the student who copied work from another student and the student who gave material to be copied will receive zero credit for the corresponding assignment. Penalty for violation of this Policy can also be extended to include failure of the course and University disciplinary action. During examinations, each student has to do only their own work. Talking or discussing is not permitted, nor students comparing their papers, copying from others, or collaborating in any way. Any collaborative behavior during examinations will result in failure of the exam and may lead to failure of the course and University disciplinary action.

Disability service information. UC Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design diversity. I am available to discuss appropriate academic accommodations that may be required for students with disabilities. Requests for academic accommodations are to be made during the first three weeks of the semester, except for unusual circumstances. Students are encouraged to register with the Disability Services Center to verify their eligibility for appropriate accommodations.

Grading.

- Exams: Midterm 20% (200 pts); Final 20% (200 pts)
- Project: 30% (300 pts = 75 (phase 1) + 75 (phase 2) + 150 (phase 3))
- Lecture quizzes: 15% (30 pts for each quiz; 5 quizzes)
- Lab assignments: 15% (15 pts for each lab; 10 labs)
- $\geq$ 950: A+; $\geq$ 900: A; $\geq$ 800: A-; $\geq$ 770: B+; $\geq$ 730: B; $\geq$ 700: B-; $\geq$ 670: C+; $\geq$ 630: C; $\geq$ 600: C-; $\geq$ 500: D; $<$ 500: F
- Curved grading may apply only in special situations.