Capitol Technology University Undergraduate Program


Educate. Innovate. Inspire.

*CS-220* *Database Management*

| | |
|---|---|
| Professor: Zane Harvey<br>Email: zwharvey@captechu.edu<br>Phone: (412) 709-2184 | Office Hours: Friday 1:00 PM – 3:00 PM ET<br>Dates/Times: Mon/Wed 1:45 PM – 3:00 PM ET<br>Location: Laurel Campus - McGowan Academic Center (M101) |

Fall 2020

**Course Description:**

An overview of database systems, with an emphasis on relational databases and the relational model. Terminology, basic analysis and database design using Entity-Relationship diagrams and relational schemas (primary-foreign key relationships). Data modeling and Normalization. Database implementation, queries, and updates in a modern relational database management system. An overview of key database concepts including transactions and concurrency. Data warehouses, OLAP vs. OLTP. NoSQL and NewSQL databases will be discussed. Database technology as a foundation for modern Artificial Intelligence applications will be demonstrated. How to decide on the correct database technology based on the workload will be discussed. Application programming for databases will be demonstrated and covered in course projects.

This course introduces database models and the fundamentals of database design. Topics include database structure, database modeling, normalization, database processing, and application programs which access a database. MySQL and MongoDB

will be used for class laboratories and projects.  Oracle database technologies will be introduced. The student should finish the course with a sound understanding of relational databases and how to construct basic and advanced SQL queries.

A review of the mathematical concepts necessary for this course will be provided during the lectures.

Upon successfully completing this course, the student will:

1. Understand the fundamentals of relational, object-oriented, and distributed database systems including: data models, database architectures, and database manipulations
2. Understand the theories and techniques in developing database applications and be able to demonstrate the ability to build databases using enterprise DBMS using MYSQL.
3. Be familiar with managing database systems
4. Understand new developments and trends in databases.

The following topics will be covered (in no respective order):

| | |
|---|---|
| SQL | NoSQL |
| NewSQL | Data modeling |
| Entity-Relationship Diagrams | Cardinality |
| Optionality | Conceptual Modeling |
| Logical Modeling | Physical Design |
| DDL vs. DML | Strong and Weak Entities |
| Simple vs. Composite Attributes | Identifiers |
| Simple vs. Composite Identifiers | Multivalued Attributes |
| Relationship degree (unary, binary, ternary) | Domain Constraints |
| Primary and Foreign Keys | Data Types |
| Referential Integrity | Normalization (1NF, 2NF, 3NF) |
| Anomalies | Coding Techniques |
| OLAP vs. OLTP | Transactions |
| Concurrency | Database Security |
| ACID | HTAP (Hybrid Transactional Analytical Processing) |
| Data Warehousing | ETL |
| Big Data | Analytics |
| Machine Learning | Dataframes (R and Python) |
| Key-Value Stores | JSON |
| XML | Hadoop |
| Cloud and Distributed Databases | Schema on Read vs. Schema on Write |
| IOT and Signal Data | Sharding |
| Horizonal vs. Vertical Scaling | Distributed Databases |
| Lambda Architectures | Columnar Storage |
| Triggers | PL/SQL and SQL/PSM |
| Versioning | Virtual Tables |
| Profiling | Benchmarking |
| Recovery | Views |
| Time Travel | In Memory Databases |
| Indexing | B-Trees |
| Docker | Kubernetes |
| Graph Databases | LAMP Stack |
| Spark/Dask | Horizontal vs. Vertical Scaling |
| Synthetic Data Generation | Deadlocks |

## Time and Locations

Classes will be held twice a week on Monday and Wednesday in the M101 room of the McGowan Academic Center from 1:45 PM ET – 3:00 PM ET.

## Required Software

- An Oracle Cloud account or installation of Oracle XE (Express)
- MySQL Community Version
- MongoDB Community Version
- Python Anaconda Distribution

## Course Materials/Books:

The course content will draw from multiple sources.

- Modern Database Management, 13th Edition, Pearson ISBN 13: 978-0-13-266225-3 **(Required)**

  Hoffer/Ramesh/Topi

  - An Introduction to Database Systems, C.J. Date
  - My own self-developed course notes/documents and other supplemental material
  - Readings will be assigned throughout the semester – the content will be provided

## Course Schedule

The schedule will follow a weekly format with three exams in the weeks provided below. Additional readings will be assigned throughout the semester.

- Note that students should read the chapters in question before the scheduled lecture

| Week/Date | Lecture Topic | Other Notes |
|---|---|---|
| 1 – 8/31/2020 | Course overview/syllabus<br>Chapter 1 Hoffer | |
| 2 – 9/7/2020 | Chapter 2 Hoffer | |
| 3 – 9/14/2020 | Chapter 3 Hoffer | |
| 4 – 9/21/2020 | Chapter 4 Hoffer | |
| 5 – 9/28/2020 | Chapter 5 Hoffer | |
| 6 – 10/5/2020 | Chapter 6 Hoffer | Exam 1 (Open Book Take Home) |
| 7 – 10/12/2020 | Chapter 7 Hoffer | |
| 8 – 10/29/2020 | Chapter 8 Hoffer | |
| 9 – 10/26/2020 | Chapter 9 Hoffer | |
| 10 – 11/2/2020 | Chapter 10 Hoffer | |
| 11 – 11/9/2020 | Chapter 11 Hoffer | Exam 2 (Timed/Proctored) |
| 12 – 11/16/2020 | Chapter 12 Hoffer | |
| 13 – 11/23/2020 | Chapter 13 Hoffer | **Fall Reading Week** |
| 14 – 11/30/2020 | Chapter 14 Hoffer | |
| 15 – 12/7/2020 | Review/Special Topics | |
| 16 – 12/14/2020 | Final Exams | Final Exam (Open Book Take Home) |

Three Exams:
Week of October 5th – Exam 1
Week of November 9th – Exam 2
Week of December 14th – Final Exam

## Grading

Grading Components:

Projects: 40% (Various reports will be requested throughout the semester, graduate students will be requested to submit extra reports)
Exam 1: 10%
Exam 2: 10%
Final: 20%
HW: 15%
Attendance: 5%

Late homework and assignments will be accepted with a 50% penalty for up to one week after due date. After one week from due date, the student will receive a score of 0.

## Course Requirements

Prerequisites: CS-130 or CS-150. You make take this course and CS-130 concurrently. Knowledge of at least one programming language

## Participation

Attendance for class is tracked in Canvas.

## Homework

Homework and projects will be due on the indicated due date in Canvas. Late homework and projects will receive 50% credit for up to 1 week after the due date. Late homework after 1 week from the due date will receive 0%.

## Communication

Emails, phone calls, text. Canvas Appointments are suggested. Course announcements will be used frequently to communicate with the class.

## Academic Integrity

Every Student is expected to be familiar with Capitol Technology University's Code of Academic Conduct including (but not limited to) the issues of cheating, plagiarism, etc. All cases of suspected academic dishonesty will be reported to the appropriate school officials, and disciplinary action may result, following investigation by a judiciary committee. Some of the core concepts are given here:

DEFINITION AND EXPECTATIONS OF ACADEMIC INTEGRITY:

**Cheating** – intentionally using or attempting to use unauthorized materials, information or study aids in any academic exercise. Examples include, but are not limited to, submitting another student's work as your own, using books or notes during closed book tests.

**Fabrication** – intentional and unauthorized falsification or invention of any information or citation in an academic exercise. Examples include, but are not limited to, changing collected data to meet the hypothesis, listing a research source that does not exist, listing a quote that does not exist.

**Facilitating academic dishonesty** – intentionally or knowingly helping or attempting to help another to violate any provision of this code. Examples include, but are not limited to, giving any individual other than the professor your completed assignment, suggesting ways to cheat or plagiarize.

**Plagiarism** – The Technology University plagiarism policy may be found online at http://www.captechu.edu/resources/lib/writingguide/plagarism.html

**Self-Plagiarism** – submitting the same paper or assignment for more than one class for a grade without the professor's knowledge or permission.

**Complicity** – failing to report the incidents of academic dishonesty to the professor, department chair, Dean of Academic Affairs, or the Vice President for Academic Affairs.

**Code of Conduct** – the academic integrity code is incorporated into the Capitol Technology University's Code of Conduct Standards.

**Judicial Process**

Any incidents should be reported to the appropriate Department Chair with written documentation. The Department Chair will forward academic integrity cases to the Academic Affairs Council for review and all other incidents to the Dean of Students. Once the case is reviewed, the Judicial Facilitator, Dean of Students or designee, will meet with the student to discuss the allegations. The student will have the opportunity to accept responsibility and sanctions or to have the case heard by a Conduct Review Panel (CRP). If a CRP is needed, the student and all other faculty, staff or students who have direct knowledge of the incident will be asked to participate in a hearing. The CRP is composed of three members who are selected by the Judicial Facilitator from a pool of faculty, staff, or students. In cases of potential violations of the Academic Integrity Code, the CRP is generally composed of faculty members. The CRP will determine if it is more likely than not that the campus policies have been violated. If the CRP finds that the policies have been violated, they will recommend sanctions. The Judicial Facilitator will notify the student in writing of the CRP's findings. The student has the opportunity to appeal to the VP for Academic Affairs.

To learn more about the official policies of the university on this issue, please read "Code of Academic Integrity" beginning on page 18 and "Sanctions for Violations of Regulations" beginning on page 63 of the Student Handbook. The Student Handbook can be downloaded from: http://www.captechu.edu/current-students/undergraduate/academic-resources

**The contents of this syllabus or the scheduled contained herein can be modified at any time without notice.by the Professor.**