Master Course Syllabus

For additional course information, including prerequisites, corequisites, and course fees, please refer to the Catalog: https://catalog.uvu.edu/

Semester: Spring
Year: 2025
Course Prefix: CS
Course and Section #: 3520 -X02
Course Title: Database Theory
Credits: 3

Course Description

Presents theory and implementation concepts of database management systems. Projects will be focused on the practical aspects of designing and implementing components of a database system.

Introduces the underlying theories of Relational Database Management Systems (RDBMS) as well as their practical use retrieving data using both embedded SQL and relational algebra. Implements queries that start from simply joining, selecting, and projecting data, then progresses to more complex data retrieval techniques that require the use of set operations, sub-queries, and group by having clauses. Discusses entity-relationship (ER) modeling, creating a RDBMS from an ER model, B+ Trees, ACID transactions, normalization, locking, concurrency issues, and alternatives to an RDBMS.
Lab access fee of $45 for computers applies.

This is a **required course** for CS majors.

Prerequisite(s): Matriculation to computer science or software engineering and University Advanced Standing.

Course Attributes

This course has the following attributes:
☐ General Education Requirements
☐ Global/Intercultural Graduation Requirements
☐ Writing Enriched Graduation Requirements
☒ Discipline Core Requirements in Program
☐ Elective Core Requirements in Program
☐ Open Elective
Other: *Click here to enter text.*

Instructor Information

Instructor Name: David Pappe

Student Learning Outcomes

At the end of the semester, students should be able to demonstrate by the end of the course:

1. Understanding Database Concepts
- Explain fundamental concepts in database theory, including data models, relational databases, and the role of databases in information systems.
- Describe the key components of a database system, including databases, database management systems (DBMS), and the data architecture.

2. Relational Model and SQL Proficiency
- Demonstrate proficiency in Structured Query Language (SQL) for defining, manipulating, and querying relational data.
- Construct complex SQL queries involving multiple tables, subqueries, joins, aggregates, and set operations.

3. Normalization and Database Design
- Apply the principles of normalization to design relational database schemas that minimize redundancy and ensure data integrity.
- Evaluate existing database designs for normalization and identify potential improvements.

4. Data Integrity and Constraints
- Analyze and implement various types of constraints (e.g., primary keys, foreign keys, and unique constraints) to ensure data integrity within a database.
- Explain the importance of data integrity and consistency within the context of transaction management.

5. Transaction Management and Concurrency Control
- Describe the properties of database transactions (ACID properties) and their significance in ensuring data integrity.
- Explain concurrency control mechanisms and how they prevent issues such as lost updates and deadlocks.

6. Indexing and Query Optimization
- Discuss the role of indexing in databases and implement indexing strategies to enhance query performance.
- Analyze query execution plans and optimize SQL queries for better performance.

7. Introduction to NoSQL and Emerging Database Technologies
- Compare and contrast relational databases with NoSQL databases, including various types of NoSQL databases (e.g., document, key-value, column-family, graph).
- Evaluate the appropriateness of different database technologies for specific use cases and data characteristics.

8. Data Modeling Techniques
- Utilize data modeling techniques, such as Entity-Relationship (ER) modeling, to diagram and design databases before implementation.
- Translate ER diagrams into a relational schema and create corresponding SQL DDL statements.

9. Understanding Distributed Databases and Cloud Storage
- Explain the concepts and challenges associated with distributed databases and cloud-based database services.

- Assess the advantages and disadvantages of using cloud databases compared to traditional on-premises solutions.

10. Ethical Considerations and Data Privacy
- Discuss ethical considerations related to database management, including data privacy, security, and compliance with regulations.
- Evaluate the implications of database design choices on user privacy and data governance.

Course Materials and Texts

Zybooks Textbook

Note: By default, students opt in to Wolverine Access, and the access code won't be available immediately. The code access might take up to a week.

For students who have **opted out** of Wolverine Access

1. Click any zyBooks assignment link in your learning management system
(Do not go to the zyBooks website and create a new account)
2. Subscribe

For students using Wolverine Access

Students participating in Wolverine Access can find their ZyBooks access code by going to your Account Menu in Canvas and clicking the "Textbooks and Course Materials" link. This will either take you straight to a page showing you your course materials, or you will be prompted to create a new account. Make sure to create an account using your UV ID email. Once you are in your account, you will see all the course materials covered by Wolverine Access, including your ZyBook materials. You can reveal your ZyBook access code by clicking the "Go to Website" button.

Tools

- Python 3.8 or latest
- MySQL
- MySQL Workbench
- DBeaver Community

These tools will be covered in more detail as needed for the class.

Test Material

- zyBooks - Reading assignments
- zyBooks - Labs
- zyBooks - Challenge Activities
- zyBooks - Case Studies
- Projects

Course Requirements

Course Assignments, Assessments, and Grading Policy

Case Studies (5% of final grade)

- This is an individual assignment.
- Case study assignments are on zyBooks. Check the link in Canvas.
- Check the canvas schedule for a case study due date. If you miss a case study, you can still submit it; however, there is a 20% daily penalty for two days. After two days, it is considered missing.

Challenge Activities (5% of final grade)

- Challenging activity assignments are on zyBooks. Check the link in Canvas.
- Check the canvas schedule for a challenging activity due date. If you miss a challenge activity, you can still submit it; however, there is a 20% daily penalty for two days. After two days, it is considered missing.

Quizzes (10% of final grade)

- Quizzes are in Canvas. This is an individual assignment.
- Check the canvas schedule for Quiz due dates. If you miss a quiz cutoff date, you miss the quiz and cannot make it up.
- All quizzes are required. They are open-book and cover materials from reading assignments and challenge activities in any preceding lessons.

Labs (5% of final grade)

- Labs and assignments are on Canvas. Lab assignments are on zyBooks. Check the link in Canvas.
- There are individual assignments.
- Check the Canvas schedule for a Lab due date. If you miss a Lab, you can still submit it; however, there is a 10% penalty per day for two days. After two days, it is considered missing.

Projects (25% of final grade)

- Projects and assignments are on Canvas. Check the link in Canvas.
- There are individual assignments.
- Check the Canvas schedule for a Lab due date. If you miss a Project, you can still submit it; however, there is a 10% penalty per day for two days. After two days, it is considered missing.

Exam 1 & 2 (20% of final grade)

- The midterm will be on Canvas. This is an individual assignment.
- The Midterm will cover Modules 1-2-3-4
- Check the canvas schedule for the midterm due date. If you miss the midterm cutoff date, you miss the midterm and cannot make it up.
- All midterms are required; they are open-book and cover materials from reading assignments and challenge activities in any preceding lessons.

Group Project (30% of final grade)

- Group Project instructions and rubric will be on Canvas.
- Check the canvas schedule for the Group Project due date. If you miss the Group Project cutoff date, you miss the Group Project and cannot make it up.
- Design and implement a transactional database
    - Example – Grocery store – Airbnb (A simple system process)
    - **Group of 4 students**
    - All four students must participate
    - Peer reviews (on Canvas)
    - Groups should be defined before midterm (you choose your own team)
    - Prepare written report
    - A template will be sent later
- Video presentation should be uploaded into Canvas (Video link or the actual video)
- It should be a professional presentation – Max 5 minutes (No more than 5 minutes and no less than 5 minutes)

Grading

This course includes lectures, homework, and exams. Homework assignments are crucial to develop a full understanding of the material. Because this is a 3000-level course, students should expect to spend time on homework every week. The practical programming aspects of this class will be assigned as lots of small homework assignments.

Late/Incorrect Submissions (Read carefully)

- Incorrect submissions will have a 20% grade reduction.
- There will be a 10% reduction for each day, up to a maximum of three days. After three days, it will be considered missing, and the grade will be 0 (zero).
- Missing work will not be graded.

IMPORTANT: if a file is corrupt (i.e., the instructor cannot open it), it will not be considered incorrect. If the wrong version of a submission is submitted and the student wants an updated version to be considered for grading, a 20% penalty will be applied.

- Study Cases 5 percent
- Challenge Activities 5 percent
- Quizes 10 percent
- Exams 20 percent
- Individual Assignments / Labs 5 percent

- Projects 25 percent
- Group Project 30 percent

Total grade 100 percent

Grades will be assigned according to the following schedule:

94% & above	A	73 – 76%	C
90 – 93%	A-	70 – 72%	C-
87 – 89%	B+	67 – 69%	D+
83 – 86 %	B	64 – 66%	D
80 – 82%	B-	60 – 63%	D-
77 – 79%	C+	0 – 59%	E

Required or Recommended Reading Assignments

Module 1: Introduction to Databases

Module 2: Database Design

Module 3: Relational Databases

Module 4: Complex Queries

Module 5: Data Storage

Module 6: Transaction Management

Module 7: Database Architecture

Module 8: Complex Data Types

Module 9: Database Programming

Module 10: NoSQL Databases

General Description of the Subject Matter of Each Lecture or Discussion

Introduction to Databases

Introductory concept about databases.

- Why do we need a Database?
- What is a Database?
- How is Data processed today?
- What is ACID?

Database Design:

- Database Development Process
  - Conceptual Database Model
  - Logical Database Model
  - Physical Database Model
- Normalization

Relational Databases:

- Data structure
- Data integrity
- Data Manipulation (DML)
- Data Definition Language (DDL)
- Data Control Language (DCL)

Complex Queries:

- Joins
- Subqueries
- SQL Functions
- Aggregate Functions
- Relational Algrebra

Data Storage

- Storage media
- Table structure
- Indexes
- Table space & partitions

Transaction Management

- Data Transactions
- MVCC
- Concurrent access
- Database Failures
- Recovery
- Sessions

Database Architecture

- MySQL Architecture
- Cloud Databases
- Distributed databases
- Replicated databases
- Data warehouses

Complex Data Types

- Simple and complex types
- Collection types

- Spatial types
- Object types

Database Programming
- Introductory concepts using ODBC connector using different programming languages

NoSQL Databases:
- Introductory NoSQL Concepts
  - Document databases
  - Columnar Databases
  - Key-Value Databases

Required Course Syllabus Statements

Generative AI
This course requires you to complete assignments that assess your understanding and application of the material. You are expected to do your own work, and the use of artificial intelligence (AI) tools, such as chatbots, text generators, paraphrasers, summarizers, or solvers, is strictly prohibited for any part of your assignments. Using these tools will be considered academic dishonesty and will be handled according to the university's policy. If you have questions about acceptable use of AI tools, please consult the instructor before submitting your work.

Using Remote Testing Software
☒ This course does not use remote testing software.

☐ This course uses remote testing software. Remote test-takers may choose their remote testing locations. Please note, however, that the testing software used for this may conduct a brief scan of remote test-takers' immediate surroundings, may require use of a webcam while taking an exam, may require the microphone be on while taking an exam, or may require other practices to confirm academic honesty. Test-takers therefore shall have no expectation of privacy in their test-taking location during, or immediately preceding, remote testing. If a student strongly objects to using test-taking software, the student should contact the instructor at the beginning of the semester to determine whether alternative testing arrangements are feasible. Alternatives are not guaranteed.

Required University Syllabus Statements

Accommodations/Students with Disabilities
Students needing accommodations due to a permanent or temporary disability, pregnancy or pregnancy-related conditions may contact UVU Accessibility Services at accessibilityservices@uvu.edu or 801-863-8747.

Accessibility Services is located on the Orem Campus in BA 110.

Deaf/Hard of Hearing students requesting ASL interpreters or transcribers can contact Accessibility Services to set up accommodations. Deaf/Hard of Hearing services can be contacted at DHHservices@uvu.edu

DHH is located on the Orem Campus in BA 112.

Academic Integrity

At Utah Valley University, faculty and students operate in an atmosphere of mutual trust. Maintaining an atmosphere of academic integrity allows for free exchange of ideas and enables all members of the community to achieve their highest potential. Our goal is to foster an intellectual atmosphere that produces scholars of integrity and imaginative thought. In all academic work, the ideas and contributions of others must be appropriately acknowledged and UVU students are expected to produce their own original academic work.

Faculty and students share the responsibility of ensuring the honesty and fairness of the intellectual environment at UVU. Students have a responsibility to promote academic integrity at the university by not participating in or facilitating others' participation in any act of academic dishonesty. As members of the academic community, students must become familiar with their rights and responsibilities. In each course, they are responsible for knowing the requirements and restrictions regarding research and writing, assessments, collaborative work, the use of study aids, the appropriateness of assistance, and other issues. Likewise, instructors are responsible to clearly state expectations and model best practices.

Further information on what constitutes academic dishonesty is detailed in UVU Policy 541: *Student Code of Conduct*.

Equity and Title IX

Utah Valley University does not discriminate on the basis of race, color, religion, national origin, sex, sexual orientation, gender identity, gender expression, age (40 and over), disability, veteran status, pregnancy, childbirth, or pregnancy-related conditions, citizenship, genetic information, or other basis protected by applicable law, including Title IX and 34 C.F.R. Part 106, in employment, treatment, admission, access to educational programs and activities, or other University benefits or services. Inquiries about nondiscrimination at UVU may be directed to the U.S. Department of Education's Office for Civil Rights or UVU's Title IX Coordinator at 801-863-7999 – TitleIX@uvu.edu – 800 W University Pkwy, Orem, 84058, Suite BA 203.

Religious Accommodation

UVU values and acknowledges the array of worldviews, faiths, and religions represented in our student body, and as such provides supportive accommodations for students. Religious belief or conscience broadly includes religious, non-religious, theistic, or non-theistic moral or ethical beliefs as well as participation in religious holidays, observances, or activities. Accommodations may include scheduling or due-date modifications or make-up assignments for missed class work.
To seek a religious accommodation, a student must provide written notice to the instructor and the Director of Accessibility Services at accessibilityservices@uvu.edu. If the accommodation relates to a scheduling conflict, the notice should include the date, time, and brief description of the difficulty posed by the conflict. Such requests should be made as soon as the student is aware of the prospective scheduling conflict.

While religious expression is welcome throughout campus, UVU also has a specially dedicated space for meditation, prayer, reflection, or other forms of religious expression.