GEOG 3140 – GIS Database Design

Winter Quarter 2025

Class Time: Monday & Wednesday 10 – 11:50 AM
Class Date: January 06, 2025 - March 17, 2025
Classroom: Boettcher Center West (BW), Room 125

Instructor: Dr. Guiming Zhang
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Office Hours: Wednesday 2 – 4 PM, or by appointment @ BW 126

1. Course Description

Geospatial database is an essential component of a Geographic information system. Designing and building an effective database is critical in improving the overall efficiency of a GIS. The course begins by providing students an overview of basic database concepts, fundamental design principles and basic techniques of building a database. It then focuses on extending traditional techniques and methodologies to model the requirements of spatial problems. Students will develop the skills to formulate a conceptual spatial data model to describe spatial data in specific applications and translate the conceptual spatial model into a physical implementation specific to GIS products.

The main content of this course will include:

- Fundamental database concepts: benefits of using databases; the history of database; functions of database management systems;
- Data modeling and database design: Entity-Relation diagrams; Relational model; Object-Oriented database design; Object-Relational database; Georelational model;
- Usages of modern commercial and open-source spatial databases products;
- Other topics related to spatial database design: spatial data sharing, warehouse, legal issues;

2. Course Objectives

Upon the completion of the course, students are able to:

- Develop a strong conceptual understanding of database design and implementation in GIS;
- Design a spatial database using spatial database models;
- Use popular database software to create and manage spatial and aspatial databases;
- Use Structured Query Language (SQL) to develop and manipulate databases;

- Perform spatial database operations with ESRI Geodatabase and/or the open-source PostGIS;
- Assess and evaluate the advantages and major limitations of existing GIS database applications;
- Understand the latest development of spatial database techniques;

3. Prerequisite

It is expected that students have taken at least **one** introductory GIS course (e.g. Introduction to GIS, Geospatial Data) and comprehended the basic usages of GIS software (e.g. ArcGIS, QGIS).

4. Textbooks and Readings

Required:
Yeung and Hall, *Spatial Database Systems: Design, Implementation and Project Management*. Springer, 2007.ISBN: 978-1-4020-5392-4
Available at DU digital library:
https://link-springer-com.du.idm.oclc.org/content/pdf/10.1007/1-4020-5392-4.pdf

Optional:
Shekhar and Chawla, *Spatial databases: a tour*. Prentice Hall, 2003.
Silberschatz, Korth and Sudarshan, *Database System Concepts, 6/e*. McGraw Hill. 2011.

Additional reading materials will be distributed through the Canvas course website.

5. Technology

You can access the software (ArcGIS Pro, PostgreSQL/PostGIS) required for this course either by remotely connecting to GIS Lab Computer through VMware, or by installing the software on your own computer. Detailed instructions regarding both options are posted on Canvas (under the *Technology Resources* module).

6. Course Assessment

	Undergraduate	Graduate
Exercises	20%	15%
Quizzes	2*10%	2*10%
Assignments	3*10%	3*10%
Discussions	NA	**5%**
Term project	30%	30%

Exercises: You will acquire hands-on experience through a series of weekly exercises. Usually, you are expected to turn in the exercises **by the end of the following weekday** (sometimes at the end the class). A portion of the class time (the last hour or so) will be dedicated to these activities.

Quizzes: Each quiz will test **concepts and content** discussed in the previous lectures. Review questions will be provided at the end of each lecture.

Assignments: A set of three **take home assignments** will give students practical

experience with SQL and the design and implementation of a small spatial database. There may be a few exercises for **extra credit** for **undergraduate** students. And these exercises are required, non-graded for **graduate** students.

Discussions: **Graduate students** are expected to participate in online discussions on different topics related to GIS database design and implementations. The topics will be posted on Canvas on a weekly basis. Every graduate student is expected to contribute at least **five** discussion entries. Undergraduate students are welcome to participate!

Term project: You are expected to demonstrate your knowledge and skills learnt in the course through a **term project**. Students are expected to deliver professional presentations on the project in class. Instructions regarding the term project will be posted on Canvas.

Grading criteria:

93-100%	A
90-92.99%	A-
87-89.99%	B+
83-86.99%	B
80-82.99%	B-
77-79.99%	C+
73-76.99%	C
70-72.99%	C-
67-69.99%	D+
63-66.99%	D
60-62.99%	D-
< 60%	F

7. Course Policies

AI Use: Students should NOT use any AI tools (ChatGPT, etc.), in part or full, to complete any graded course work in this class, including response to discussion questions, exercises, assignments, quizzes and projects. If you desperately need AI for a specific task (e.g., writing an SQL query for the term project), discuss it with the instructor first to obtain permission. Otherwise, **any unauthorized AI usage will result in a zero for the submitted work**.

Late Submission: Students are expected to turn in assignments and project updates before the due dates specified on the Canvas course website. Failing to do so will result in a **5%** deduction per day from the points received for each assignment and project update/report. No late submissions will be accepted after one week of the due date.

Academic Misconduct: Most work submitted in this class is to be an individual effort. Although working collaboratively on in-class exercises in small groups (2-3 people) is allowed, each student must complete and submit their own work. Submitting the work of others, in total or in part, or providing work to others to be submitted as their own, **will result in a zero for the exercise/assignment.** For the consequences of violating the Academic Misconduct policy, refer to the University of Denver website on the Honor Code. See Student Rights & Responsibilities websites for information on the Student

Conduct Policies and Procedures.

Disability Accommodations: All academic accommodations regarding disabilities (i.e., physical, medical, mental, emotional, learning, etc.) must be arranged through the Student Disability Services (SDS) (https://studentaffairs.du.edu/disability-services-program or 303-871-3241).

Religious Accommodations: University policy grants students excused absences from class or other organized activities or observance of religious holy days, unless the accommodation would create an undue hardship. You must notify me by the end of the first week of classes if you have any conflicts that may require an absence. It is your responsibility to make arrangements with me in advance to make up any missed work or in-class material.

Student Athletes: If you are a student-athlete, you should inform me of any class days to be missed due to DU sponsored varsity athletic events in which you are participating. Please provide me with an absence policy form by the end of the first week of class. You will need to make up any missed lectures, assignments, and/or exams.

Inclusive Learning Environments: In this class, we will work together to develop a learning community that is inclusive and respectful. Our diversity may be reflected by differences in race, culture, age, religion, sexual orientation, socioeconomic background, and myriad other social identities and life experiences. The goal of inclusiveness, in a diverse community, encourages and appreciates expressions of different ideas, opinions, and beliefs, so that conversations and interactions that could potentially be divisive turn instead into opportunities for intellectual and personal enrichment.
A dedication to inclusiveness requires respecting what others say, their right to say it, and the thoughtful consideration of others' communication. Both speaking up and listening are valuable tools for furthering thoughtful, enlightening dialogue. Respecting one another's individual differences is critical in transforming a collection of diverse individuals into an inclusive, collaborative and excellent learning community. Our core commitment shapes our core expectation for behavior inside and outside of the classroom.

Title IX: Gender violence can happen to anyone regardless of race, class, age, appearance, gender identity, or sexual orientation. The University of Denver is committed to providing an environment free of discrimination on the basis of sex (gender), including sexual misconduct, sexual assault, relationship violence, and stalking. The Center for Advocacy, Prevention and Empowerment (CAPE) provides programs and resources to help promote healthy relationships, teach non-violence and equality, and foster a respectful and safe environment for all members of the University of Denver community. All services are confidential and free of charge.

For assistance during business hours, call 303-871-3853 and ask to speak to the Director of CAPE. After hours, please call the Emergency & Crisis Dispatch Line at 303-871-3000and ask to speak to the CAPE advocate on call.

8. Tentative Class Schedule (E: Exercise; A: Assignment; P: Project; Q: Quiz)

The following class schedule is ***subject to change***. You are responsible for keeping up with the readings, quiz dates, and lectures. Any changes to this schedule will be announced in class and posted to the course Canvas page.

Week	Topic	Readings	Activities/Assignments
1/6	Database, spatial database and GIS	Chapter 1	**E**: Geodatabase vs. Shapefile
1/8	Database concepts	Chapter 2	**E:** Conceptual modeling **A1** posted
1/13	Entity-Relation model: entity	Chapter 3	**E**: Design an ER diagram
1/15	Entity-Relation model: relationship		**E**: Design an ER diagram
1/20	MLK Holiday		
1/22	Relational schema: normal forms	Chapter 3	**E:** ER model to relational schema **P**: Project team due
1/27	Relational schema: from ER diagram to relational schema		**E:** ER model to relational schema
1/29	Structured query language (SQL) – Data definition	SQL tutorial	**Quiz #1** (On Canvas) **E**: SQL tutorial **A1** due. **P:** Proposal update I due
2/3	SQL – Data manipulation		**E**: SQL tutorial **A2** posted
2/5	SQL – Data control		**E**: SQL tutorial **P**: Proposal update II due
2/10	Spatial database models	Chapter 4	
2/12	Geodatabase (GDB) – Attribute domains, subtypes	Geodatabase tutorial	**E**: Geodatabase tutorial **A2** due.
2/17	GDB – Relationship and topology		**E**: Queries in Geodatabase **A3** posted
2/19	GDB design steps		**Quiz #2** (On Canvas) **E**: Geodatabase review exercise
2/24	PostGIS	PostGIS tutorial	**E**: PostGIS tutorial.
2/26	PostGIS		**E**: PostGIS tutorial **A3** due. **P**: Proposal update III due
3/3	Project proposal presentation		
3/5	Project implementation		
3/10	Project implementation		
3/12	Project presentation		
3/17	No class. Write project report on your own.		

3/19	Project report due

* See Canvas course website for specific due dates.