DAEN 489 / ISEN 489 Spatial Data Engineering (Special Topics)

Spring 2026

Course Information

Time (location) Thursdays 12:45–3:15 PM *3 credit hours* (ZACH 211)
Prerequisites Familiarity with basic data structures, statistics, and coding.
Instructor Alexander Abuabara mailto:abuabara@tamu.edu
Course office hours (location) Wednesdays 1-3 PM or by appointment (ETB 4013)

Description

This course provides engineers with both theoretical foundations and practical skills in spatial databases and geographic information systems (GIS), with emphasis on spatial data modeling, storage, querying, analysis, and visualization. Students will learn to use open source tools to handle real spatial datasets, build spatial databases, perform spatial analysis, and integrate GIS solutions in engineering workflows.

Outcomes

1. Identify and explain spatial data types, apply coordinate reference systems, and assess spatial data quality.
2. Manipulate large spatial data (extract, clean, transform); model data structures to reflect spatial relationships and analytical requirements, design spatially enabled database systems that support reproducible GIS workflows.
3. Evaluate privacy, licensing, and ethical considerations related to spatial data.
4. Perform spatial analysis to solve practical problems.
5. Collaborate effectively in teams to design and implement spatial solutions.
6. Communicate results through maps, visualizations, and written reports.

Expectations

- Maintain academic integrity in all work.
- Prepare by completing assigned readings before class.
- Participate in discussions and problem-solving activities.
- Submit assignments and project on time, demonstrating responsibility and clear communication.

Materials

- *Textbooks*: – Campbell et al. *Essentials of GIS*. https://open.umn.edu/opentextbooks/textbooks/67
  - Pebesma et al. *Spatial Data Science With Applications in R*. https://r-spatial.org/book
  - Lovelace et al. *Geocomputation with R*. https://r.geocompx.org
    Geocomputation with R in Docker https://hub.docker.com/r/geocompr/geocompr
  - Dorman et al. *Geocomputation with Python*. https://py.geocompx.org
- Lectures and notes (posted on Canvas)

Grading

Assessment	Weight	Description
Attendance/participation	10%	In-class quizzes, discussions, peer feedback
Assignments	30%	Practices, biweekly assignments (short report + maps + code)
Midterm exam	30%	Theoretical questions (covering week 1–8)
Project	30%	Applied spatial analysis in an engineering context (in groups of 2)

- Grades will be calculated by totaling the points you earn and comparing them to the max. possible points.
- Grades assigned are A: 90%–100%, B: 80%–89.9%, C: 70%–79.9%, D: 60%–69.9% and F for less than 60%.

Assignments

Topic (*may be adjusted*)	Due week
1. Projection Distortion: compare different coordinate systems	2
2. ETL Workflow: load, clean, handle missing values, convert format, reproject	4
3. Raster–Vector Interaction: population distribution and characteristics	6
4. Data Cube Construction: time series of population distribution	8
5. Engineering Decision-Making: hazard analysis combining elevation, floodplain, and building footprints	10
6. Project Proposal: large-scale spatial data integration, analysis, and visualization (*groups of 2*)	12
7. Project Presentation: *story map* (*groups of 2*)	14
8. Project Report: *~12 pp. including automated workflow, hi-res maps, and reproducible code* (*groups of 2*)	15

Schedule (Updated)

We'll try to follow this schedule, but since this is my first time working through these books, I'm not 100% sure I've got their content spaced our correctly, so we can be flexible and make adjustments as needed.

Week	Topic (*includes link for key readings, more on Canvas*)
1 (1/15)	Spatial thinking
2 (1/22)	Coordinate systems and geographic data
3 (1/29)	Attribute data operations, spatial ETL (pre-processing, workflows)
4 (2/05)	Spatial operations
5 (2/12)	Geometric operations on vector data
6 (2/19)	Geometric operations on raster data & data cubes
7 (2/26)	Raster-vector interactions
8 (3/5)	**Midterm exam** *(in class)*
Spring break (3/7–15)	
9 (3/19)	Making maps and cartographic design, reprojecting, I/O
10 (3/26)	Pipelines and workflow automation, large data and web GIS/APIs (Leaflet, OpenLayers, MapBox)
11 (4/2)	Spatial statistics (ESDA, spatial autocorrelation, point pattern, interpolation)
12 (4/9)	Spatial modeling (spatial regression, spatial econometric models) **(project proposal due)**
13 (4/16)	Case studies in engineering (network analysis, suitability, terrain analysis, remote sensing, digital twin, spatial-ML, AI)
14 (4/23)	**Project presentation** *(in class)* and reflection on best practices
15 (4/30)	**Project report due** *(no class meeting)*

Policies

- **Be nice. Be honest. Don't cheat. Adhere to University Policies.**
- Course material is cumulative and requires consistent effort. All assignments must be completed carefully and on time. Presentation quality (organization, clarity, tables, graphs, maps, and discussion) is part of grading.
- Regrade applies to the entire submission. To ensure fairness and timely feedback, no changes after one week.
- E-mail is the primary method of communication. Include the course number (DAEN/ISEN 489) in the subject line. Responses should not be expected after 5:00 PM, on weekends, or on holidays.
- All assignments must be submitted through Canvas. If technical issues prevent submission, send your assignment from your `@tamu.edu` email to the instructor's `@tamu.edu` email as a backup. The subject line must include the course number and assignment name. Late work is not accepted and will receive a grade of zero.
- Students should engage actively, stay current with readings, participate, and seek help early.
- Excused absences apply only to attendance and in-class activities and do not extend assignment deadlines. As possible, alternatives must be arranged prior to deadline.
- Audio or video recording of lectures or any portion of the course is prohibited.
- Headphones and non-class-related browsing are not permitted during class.
- AI (including chatbots and text, code, image, audio, and video generators) may be used responsibly and within defined limits. You may use AI for brainstorming and for reviewing your own work for grammar, punctuation, spelling, clarity, and brevity. Use AI in ways you would feel comfortable explaining to your instructor and classmates. AI should support your learning process, not replace it. There are no "silly" questions in this course, so do not avoid asking questions, participating in class, or seeking help in favor of relying on AI. You may NOT use AI to write your assignments for you, solve broad problems or programming tasks, or generate analyses or substantive content. All submitted work must always reflect your own independent effort. Misuse of AI may be treated as a violation of academic integrity.

University Policies

Academic Integrity Statement and Policy

"An Aggie does not lie, cheat or steal, or tolerate those who do." "Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" (Section 20.1.2.3, Student Rule 20). You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at **aggiehonor.tamu.edu**.

University Attendance Policy

The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments. Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Course Specific Attendance Policy

Class attendance is required of all students for introductory (first two weeks) and phase kick-off sessions (as noted on schedule). For team presentation days, attendance is required for the entire class time for all team members in the specified group. Attendance on presentation days for the alternate group is allowed and encouraged.

Makeup Work Policy

Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor. Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines. Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor" (Student Rule 7, Section 7.4.1). "The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence" (Student Rule 7, Section 7.4.2). Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24.)

Notice of Nondiscrimination

Texas A&M University is committed to providing safe and non-discriminatory learning, living, and work environments for all members of the University community. The University provides equal opportunity to all employees, students, applicants for employment or admission, and the public, regardless of race, color, sex (including pregnancy and related conditions), religion, national origin, age, disability, genetic information, or veteran status. Texas A&M University will promptly, thoroughly, and fairly investigate and resolve all complaints of discrimination, harassment (including sexual harassment), complicity, and related retaliation based on a protected class in accordance with System Regulation 08.01.01, University Rule 08.01.01.M1, Standard Administrative Procedure (SAP) 08.01.01.M1.01, and applicable federal and state laws. In accordance with Title IX and its implementing regulations, Texas A&M does not discriminate on the basis of sex in any educational program or activity, including admissions and employment. The following person has been designated to handle inquiries and complaints regarding the non-discrimination policies: Jennifer M. Smith, TAMU Associate VP & Title IX Coordinator at YMCA Ste 108, College Station, TX 77843, 979-458-8407, or email **civilrights@tamu.edu**. For other reporting options, visit the U.S. Department of Education Office for Civil Rights Complaint Assessment System to locate the address and phone number of the office that serves your area, or call 1-800-421-3481.

Civil Rights, Free Speech, and Title IX Policies

Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit discrimination and harassment based on an individual's race, color, sex, (including pregnancy and related conditions), religion, national origin, age, disability, genetic information, veteran status, or any other legally protected characteristic. This includes forms of sex-based violence, such as sexual assault, sexual harassment, sexual exploitation, dating/domestic violence, and stalking. Students can report discrimination/harassment, access supportive resources, or learn more about their options for resolving complaints on the University's Civil Rights & Title IX webpage. Students should be aware that all university employees (except medical or mental health providers) are mandatory reporters, which means that if they observe, experience or become aware of an incident that they reasonably believe to be discrimination/harassment alleged to have been committed by or against a person who was a student or employee at the time of the incident, the employee must report the incident to the university.

Americans with Disabilities Act (ADA) Policy

Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact the Disability Resources office on your campus (resources listed below). Disabilities may include, but are not limited to, attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to

discuss their disability-related needs with Disability Resources and their instructors as soon as possible. To request academic accommodations, contact the designated ADA office based on your location: Texas A&M College Station should contact Disability Resources at (979) 845-1637 or **disability@tamu.edu**. If you are experiencing difficulties with your approved accommodations, contact the office responsible for approving your accommodations or the Texas A&M ADA Coordinator Julie Kuder at **ADA.Coordinator@tamu.edu** or (979) 458-8407.

Pregnancy Accommodations

Texas A&M provides reasonable accommodations to students due to pregnancy and/or related conditions, such as childbirth, recovery, and lactation. Students should contact the University's Pregnancy Coordinator as soon as they become aware of the need for accommodation. Depending on the circumstances, accommodations could include extended time to complete assignments or exams, changes in course sequence, or modifications to the physical classroom environment. Texas A&M will also allow a voluntary leave of absence, ensure the availability of lactation space, and maintain grievance procedures to provide for the prompt and equitable resolution of complaints of sex discrimination. For information regarding pregnancy accommodations, email **TIX.Pregnancy@tamu.edu**.

Statement on Mental Health and Wellness

Texas A&M University recognizes that mental health and wellness are critical factors influencing a student's academic success and overall wellbeing. Students are encouraged to engage in healthy self-care practices by utilizing the resources and services available through University Health Services. The TELUS Health Student Support app provides access to professional counseling in multiple languages anytime, anywhere by phone or chat, and the 988 Suicide & Crisis Lifeline offers 24-hour emergency support at 988 or **988lifeline.org**. Students needing a listening ear can contact University Health Services at 979.458.4584. Call 911 or visit your nearest emergency room if you are currently experiencing a life-threatening situation or if your safety is at risk. 24-hour emergency help is also available through the 988 Suicide & Crisis Lifeline (988) or at **988lifeline.org**.

Statement on the Family Educational Rights and Privacy Act (FERPA)

FERPA is a federal law designed to protect the privacy of educational records by limiting access to these records, to establish the right of students to inspect and review their educational records, and to provide guidelines for the correction of inaccurate and misleading data through informal and formal hearings. Currently enrolled students wishing to withhold any or all directory information items can do so within **howdy.tamu.edu** using the Directory Information Withholding Form. The complete FERPA Notice to Students and the student records policy is available on the Office of the Registrar webpage. Items that can never be identified as public information are a student's social security number, citizenship, gender, grades, GPR, or class schedule. All efforts will be made in this class to protect your privacy and to ensure confidential treatment of information associated with or generated by your participation in the class. Directory items include name, UIN, local address, permanent address, email address, local telephone number, permanent telephone number, dates of attendance, program of study (college, major, campus), classification, previous institutions attended, degrees, honors and awards received, participation in officially recognized activities and sports, medical residence location, and medical residence specialization.