VIP 2601

Smart City Infrastructure (SCI)

Course Syllabus · Fall 2026 · 1–3 Credit Hours

Instructor Information

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TAs: To be announced at the first full-team meeting of the semester

Office Hours: By appointment — request via Canvas message or email

General Course Information

Course Description

The Vertically Integrated Projects (VIP) — Smart City Infrastructure (SCI) course operates in a sustained research and development context. Students at every level — freshmen through seniors (ECE/CS 2811–4812) and graduate students including OMSCS — work together in long-term, multidisciplinary teams under direct faculty mentorship. Academic credit is awarded for substantive research participation: designing studies, developing algorithms, collecting and analyzing real-world data, and producing publication-quality outputs.

SCI research focuses on intelligent infrastructure health and safety assessment using emerging sensor technologies, machine learning, computer vision, GIS/spatial-temporal analysis, and multi-source data fusion. Research outputs support smart city decision-making — from pothole detection and pavement management to autonomous vehicle safety and infrastructure asset optimization. The course has an active publication record in leading transportation, civil engineering, and computer vision venues, and student co-authorships are a realistic goal.

This syllabus applies uniformly to all VIP sections, OMSCS Special Problems, and undergraduate independent research registrations under the SCI umbrella. The research content, grading framework, and professional expectations are identical across all registration types; credit-hour requirements reflect proportional time investment.

Course Learning Outcomes

This course has two integrated sets of objectives — technical research objectives grounded in the SCI project mission, and research and professional skill objectives aligned with the VIP Program's broader educational goals.

Part A: Technical & Research Objectives

- **Infrastructure Health Monitoring & Diagnosis:** Apply emerging sensor technologies (smartphones, 2D/3D imaging, LiDAR, UAV, GPS/GIS) together with machine learning, computer vision, and multi-source data fusion to detect, diagnose, and visualize roadway infrastructure health conditions and safety hazards.
- **Dynamic Mapping & Predictive Safety Analysis:** Develop dynamic maps and predictive models for road asset defects (potholes, cracking, dangerous sections), enabling proactive safety improvement and evidence-based maintenance planning.

- **Multi-Source Sensing & Data Fusion:** Investigate the characteristics of heterogeneous sensing data (smartphone accelerometers, 3D laser scanning, mobile LiDAR, GPS/IMU, UAV imagery) and develop methods for multi-scale, multi-frequency data fusion and spatiotemporal analysis.
- **Smart City Solutions & 3R Asset Management:** Integrate sensor hardware, algorithms, and engineering workflows to build practical smart city tools and location-based services that deliver the Right treatment, at the Right place, at the Right time (3R) for cost-effective and sustainable infrastructure asset management.

Part B: Research & Professional Skill Objectives

- **Independent Research Capability:** Conduct an independent literature review, define a SMART research question, design and execute a research plan, and synthesize findings into a publication-quality technical report or manuscript.
- **Critical Thinking & Problem Solving:** Analyze open-ended, real-world engineering problems from multiple perspectives, break them into manageable tasks, and propose well-reasoned alternative solutions rather than merely escalating problems.
- **Communication & Team Collaboration:** Collaborate effectively in a cross-disciplinary, vertically-integrated team; produce clear meeting minutes and technical documentation; and present research progress concisely and professionally in 5–10 minute seminar-style updates.
- **Professional Ownership & Accountability:** Demonstrate the professional habits expected in a research environment: proactively initiate and complete tasks, respond to communications promptly, maintain accurate documentation, and take full responsibility for the quality and timeliness of individual contributions.

Required Course Materials

No textbook purchase is required. All course materials and announcements are distributed through Canvas and email. The MS Teams shared folder and GitHub are used for research collaboration and file management. Students are responsible for:

- Peer-reviewed literature — identified through Google Scholar, IEEE Xplore, ASCE Library, Transportation Research Record, and Scopus. Students maintain a personal literature tracking spreadsheet updated weekly.
- Software (free/open-source): Python 3.10+, PyTorch or TensorFlow, OpenCV, QGIS, Git/GitHub. Installation guides are available on MS Teams.
- Georgia Tech licensed software: ArcGIS Pro, MATLAB — available through the GT Office of Information Technology (oit.gatech.edu).
- MS Teams shared folder — organized per the VIP Student and Mentor Guide folder structure: Code, Data, Literature, Documentation, Presentations, and individual User folders.
- GitHub — required for all code. Each subteam maintains a dedicated repository with README, sample data, and developer documentation.

Credit Hours and Working Time Expectations

Georgia Tech policy requires approximately three hours of student effort per week per credit hour for 15-week courses. In VIP/SCI, one credit hour equates to four hours of independent research work per week (meetings plus out-of-meeting effort), consistent with Georgia Tech VIP Program norms.

Registration	Weekly Hours	Semester Total	Typical Scope
1 Credit Hour	4 hrs/week	~64 hrs/semester	Literature review; small coding tasks; meeting attendance
2 Credit Hours	8 hrs/week	~128 hrs/semester	Data collection/processing; algorithm prototyping; report writing

Registration	Weekly Hours	Semester Total	Typical Scope
3 Credit Hours	12 hrs/week	~192 hrs/semester	Full research cycle; OMSCS expected level; publication contribution

OMSCS students are required to register for 2–3 credit hours to ensure sufficient depth of engagement. Undergraduate students may register for 1–3 credit hours depending on their role and availability.

Grading Policy

Final grades in this course are determined by mentor evaluation across seven rubric categories, assessed twice per semester (midterm check and final evaluation). A-F grading applies per Georgia Tech Regulation.

Category	Weight	Key Criteria
1. Meeting Attendance	10%	Attendance (7%) + Punctuality (3%)
2. Communication & Participation	15%	Active questioning (5%), listening (5%), responsiveness (5%)
3. To-Do List Preparation	10%	Oral confirmation (3%), written list shown (4%), completeness (3%)
4. Assignment Completion	10%	Timeliness (5%) + Quality (5%)
5. Presentations	15%	Slide format (3%), content depth (7%), oral delivery (5%)
6.1 Code Deliverables	20%	Quality & comments (5%), completeness (5%), documentation (5%), demo (5%)
6.2 File Management	5%	MS Teams folder structure per VIP Guide
6.3 Final Report	15%	Format (5%), content completeness (5%), usability (5%)
7. Bonus Opportunities	+10%	Improvement, mentoring, leadership, ideas, outstanding deliverables

Letter Grade Thresholds: A ≥ 90% B ≥ 80% C ≥ 70% D ≥ 60% F < 60%

Detailed Description of Graded Components

1. Meeting Attendance (10%)

Students are expected to attend scheduled full-team and subteam meetings, arrive on time, and communicate absences or delays in advance whenever possible. **Full-team meetings are usually held during the first one to two weeks for onboarding purposes, typically on Wednesdays 8:25–9:15 AM in SEB 122 (as announced on Canvas).** Subteam meetings are scheduled at the beginning of the semester by your mentors. Attendance is recorded each week. An "asked leave" (advance notice before meeting start) carries less penalty than an unannounced absence. Punctuality (3%) is evaluated separately from attendance (7%).

2. Communication & Participation (15%)

Research is a collaborative discipline — communication quality matters as much as technical output. Active questioning (5%): students are expected to prepare and ask at least one substantive question per week, either before the meeting (via email or Canvas) or during it. Active listening and contribution (5%): students acknowledge others' updates, ask clarifying questions, and make constructive comments. Responsiveness

(5%): emails and Canvas messages receive a reply within the same business day in >70% of cases. Silence is not acceptable as a default response.

3. To-Do List Preparation (10%)

At the beginning of every meeting, students display their written to-do list from the previous session and verbally confirm progress on each item (3%). The list must be visible and presented — not merely recalled orally (4%). Completeness is also graded: if a mentor assigns three tasks, the student's written list must capture all three, not just the ones the student intends to prioritize (3%). This habit is modeled on professional project management practice and is taken seriously.

4. Completion of Assignments (10%)

Weekly tasks are assigned by mentors following each meeting and evaluated the following week. Timeliness (5%): >70% of assignments completed by the agreed deadline = Good. Quality (5%): mentor satisfaction with the output based on stated expectations. Students who anticipate missing a deadline must communicate proactively before it passes — not after.

5. Presentations (15%)

Presentations occur at two formal points — midterm (October 1–8) and final (November 27 – December 4) — in a seminar format. Sessions are recorded. Each group also provides peer reviews of three other groups following the established SCI standard. Evaluation covers: slide format and visual organization (3%), technical content depth, accuracy, and narrative clarity (7%), and oral delivery including pacing, confidence, handling of Q&A, and time management (5%). Presentation templates are available on MS Teams.

6.1. Code Deliverables (20%)

All code must be version-controlled in GitHub and maintained in the designated code folder on MS Teams. Evaluation criteria: coding quality, clarity, formatting, and inline explanation comments (5%); code completeness and usability — does the code run end-to-end on sample data? (5%); developer documentation including README, function docstrings, and a sample data package (5%); and a recorded individual code demo and transfer session (5%) — this session facilitates knowledge transfer and is a required individual deliverable. If no gradeable code is produced by a student, the 20% weight is redistributed evenly to sections 6.2 and 6.3.

6.2. File Management (5%)

Students maintain all project artifacts in the MS Teams shared folder per the structure defined in the VIP Student and Mentor Guide: Code (GitHub-synced), Data, Documentation, Literature, Presentations, and individual User folders. Meeting minutes are stored in each user's personal folder. Files must use descriptive naming conventions (YYYY-MM-DD_Description_Version) to enable future team members to navigate the archive efficiently.

6.3. Final Report (15%)

The final report is a research-quality technical document following academic paper structure: Abstract, Introduction and Literature Review, Research Objectives, Methodology, Data and Analysis, Results, Discussion, Conclusions, and References. At the end of semester, evaluation covers: format, readability, and adherence to professional standards (5%); content completeness — all sections present with substantive content (5%); and usability and scholarly contribution — does the report contain novel findings or results that meaningfully advance the project? (5%). A high-quality final report is the primary foundation for a future journal or conference paper submission.

7. Bonus Opportunities (up to +10%)

Bonus credit is awarded for exceptional contributions beyond baseline rubric expectations:

- Demonstrated improvement across the semester — recognized per item by mentor at final review (+1% each)
- Provided significant mentorship to teammates, e.g., organized individual training sessions for new members (+2%)
- Served as subteam or full team leader and demonstrated measurable leadership effectiveness (+3%)

- Contributed a constructive idea or technical feedback that meaningfully changed the team's research direction (+2%)
- Demonstrated strong independent learning — proactively learned and applied new methods not directly taught (+2%)
- Produced exceptionally high-quality deliverables that exceed mentor expectations in depth or polish (+2%)

Professional Expectations (SCI Research Culture)

SCI is modeled on established industry leadership frameworks, adapted for an academic research context. The following principles define the professional culture of this team and are evaluated through the grading rubric. Students are expected to internalize these values, not merely comply with them.

Principle	Expectation & Example
Accountability	Be reliable and responsible. Resolve problems and provide timely, high-quality responses without excuses. Take proactive action before being asked.
Ownership	Take full responsibility for your work and decisions. See tasks through to completion. Do not hand off partially completed work without documentation.
Big Picture	Understand how your individual contribution connects to the team's research goals and to the broader mission of smart city development.
Leadership	Inspire and guide teammates. Volunteer to lead tasks, document decisions, and mentor newer team members even when not explicitly assigned to do so.
Active Attitude	Do not wait until the weekly meeting to start work or ask questions. Meetings are for progress updates and new task assignments — work happens between meetings.
Problem-Solving	Do not bring only problems — bring potential solutions. Employers and faculty mentors prefer team members who independently explore options before escalating.

A useful daily check: "Would I be comfortable if my advisor/PI saw exactly what I am working on right now?" If not, adjust course immediately.

Course Schedule

The schedule below reflects a typical Fall semester arc. Specific subteam milestones, paper submission deadlines, and conference targets will be finalized and posted on Canvas by Week 2. All dates are subject to revision with advance notice via Canvas.

Full-Team Meeting: Wednesdays, 8:25–9:15 AM · Location TBD (posted on Canvas before Week 1)

Subteam Meetings: Scheduled by group mentors during the first two weeks of the semester

Wk	Topic / Milestone	Activities & Deliverables
1	Orientation & Team Formation	Introductions; project and subteam overview; set up MS Teams / GitHub; review VIP expectations and grading rubric
2	Literature Review Kickoff	Google Scholar / IEEE Xplore search strategy; begin literature tracking spreadsheet; identify ≥5 seed papers per student

Wk	Topic / Milestone	Activities & Deliverables
3	Research Question Definition	Synthesize literature; define SMART research question; present gap analysis; assign subteam roles
4	Methods & Data Planning	Sensor and data overview; design data-collection plan; identify publication target with mentor
5	Progress Check #1	Show to-do list; subteam status update; mentor written feedback; set mid-semester goals
6	Data Collection / Algorithm Dev.	Begin data collection or algorithm prototyping; document all procedures; version-control code
7	Mid-Semester Presentation (Oct 1–8)	5–10 min subteam presentation in seminar format; recorded; three peer-group reviews
8	Analysis & Iteration	Process data; refine methods; address technical blockers; update literature review
9	Progress Check #2	Updated to-do lists; mentor feedback; identify conference/journal submission timeline
10	Advanced Development	Code testing and documentation; draft figures, tables, and results sections
11	Publication Planning	Select target venue; outline paper structure; assign writing tasks by student
12	Draft Report / Paper Writing	First complete draft of deliverable report or manuscript section; internal peer review
13	Revision & Finalization	Revise based on mentor feedback; finalize figures; begin code demo preparation
14	Code Demo & Transfer	Individual recorded demo sessions (scheduled by mentor); transfer to MS Teams code folder
15	Final Presentations (Nov 27–Dec 4)	10-min full-team presentations; seminar format; recorded; peer group review
16	Final Report & Code Submission	Submit final report, documented code, and all deliverables to MS Teams shared folder

Research Capability Development and Publication

Research Development Pathway

SCI distinguishes itself from conventional coursework by targeting genuine scholarly output. The research development arc for each student follows four stages:

- Mastery (Weeks 1–4): Read and synthesize ≥10 peer-reviewed papers in your subarea. Be able to explain the state of the art and identify at least one open problem your work could address.
- Execution (Weeks 5–9): Design and run experiments, collect or process data, prototype algorithms. Document procedures completely enough for a teammate to reproduce your work.
- Analysis and Writing (Weeks 10–13): Produce and interpret results. Draft report sections or paper sections. Select a specific target publication venue with mentor guidance.
- Delivery (Weeks 14–16): Finalize code, complete documentation, prepare polished presentation, submit final report. Lay groundwork for post-semester publication submission.

Publication Targets

Students are encouraged — and OMSCS students are expected — to produce output that contributes meaningfully toward a peer-reviewed publication. Target venues include: Transportation Research Record (TRR), ASCE Journal of Infrastructure Systems, IEEE Transactions on Intelligent Transportation Systems (T-ITS), IEEE Conference on Computer Vision and Pattern Recognition (CVPR), and related venues. Mentors will identify a specific target with each subteam by Week 4. A student who produces a high-quality final report and reproducible code is well-positioned for a co-authored submission.

OMSCS-Specific Expectations

OMSCS students bring graduate-level depth and are expected to contribute at a correspondingly higher standard. Specifically: lead the literature review for your subteam's area; take primary responsibility for algorithm design and evaluation; produce at least one complete, documented codebase; and draft at least one paper section (methods, results, or literature review) suitable for inclusion in a journal or conference manuscript. OMSCS students registering for 2–3 credit hours must plan their independent work time accordingly (8–12 hours/week outside meetings).

Active Research Topics and Technologies

Students are assigned to subteams based on background, interests, and team needs. Active research areas for Fall 2026 include:

Infrastructure Health Monitoring

- Pavement distress detection and severity classification using deep learning (CNN, transformer, YOLO variants)
- 3D LiDAR and mobile mapping for road surface condition assessment
- Crack propagation modeling and time-series prediction using generative AI (GAN, diffusion models)
- Structural health monitoring via sensor fusion and anomaly detection

AI and Computer Vision for Transportation

- Multi-scale object detection for roadway assets (signs, markings, guardrails, curbs)
- Spatiotemporal data analysis and forecasting of infrastructure deterioration
- Transfer learning and domain adaptation for cross-city model generalization

Sensing and Multi-Source Data Fusion

- Fusion of smartphone accelerometers, 3D laser scanners, GPS/IMU, and UAV imagery
- Signal and image processing for noisy, low-cost sensor environments
- Cloud and parallel computing for large-scale infrastructure dataset processing

Smart City Decision Support

- GIS-integrated dashboards and visualization for asset management and safety analytics
- Crowdsourcing platforms for real-time citizen-reported infrastructure defects
- 3R optimization — Right treatment, Right location, Right time — for cost-effective maintenance planning

Eligible Majors and Prerequisites

Eligible Majors: Civil Engineering · Computer Engineering · Electrical Engineering · Computer Science (BS and OMSCS) · Industrial Engineering · Environmental Engineering · Mechanical Engineering · City and Regional Planning · Geographic Information Science and Technology · Computational Media · Analytics (MS Online)

Prerequisites: None required. Students should have interest in at least one of: machine learning, computer vision, GPS/GIS, mobile computing, or transportation/infrastructure systems. Programming experience (Python preferred) is strongly recommended. OMSCS students must register for 2–3 credit hours.

Confidentiality: All students must sign the SCI Team Confidentiality Agreement (available on MS Teams) before accessing shared data or code repositories. Research data involving sponsor organizations or proprietary datasets is not to be shared outside the team.

Course Policies

Attendance and Participation

Regular attendance at the full-team Wednesday meeting and all subteam meetings is required. Absences must be communicated in advance ("asked leave") via email to the mentor before the meeting starts. Unannounced absences are recorded as such. Students who miss a meeting are responsible for reviewing meeting minutes posted by the TA and completing all assigned tasks regardless of absence. Repeated unexcused absences will result in grade reduction and may result in removal from the team with an academic penalty per VIP Program policy.

Review Institute expectations on attendance at: catalog.gatech.edu/rules/4/. Faculty are also sensitive to conflicts with All-Majors Career Fair and similar University events — communicate in advance.

Academic Integrity

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. See Georgia Tech's Honor Code and the Student Code of Conduct. Any student suspected of cheating or plagiarism will be reported to the Office of Student Integrity.

AI tools (e.g., Microsoft Copilot, ChatGPT, GitHub Copilot) may be used for language editing, brainstorming, and code scaffolding. Georgia Tech students are encouraged to use Microsoft Copilot, available through GT's official license. However, students remain fully responsible for the originality, accuracy, explainability, testing, and documentation of all submitted work. AI-generated literature summaries, analytical claims, or code that the student cannot explain or debug are not acceptable unless explicitly disclosed to and approved by the mentor. Undisclosed use of AI to generate substantive deliverable content — including literature reviews, research conclusions, or complete code modules — constitutes a violation of the Honor Code.

Late Work Policy

Research timelines are interconnected — your deliverables often unblock teammates. Communicate with your mentor before a deadline if you anticipate missing it. Late submissions without prior communication will incur a 20% deduction per week late. Documented medical or family emergencies are handled individually at instructor discretion — contact Dr. Tsai promptly. Extension requests made after a deadline has passed will not be considered.

Accommodations for Students with Disabilities

If you have learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible. Please also email Dr. Tsai promptly so arrangements can be made for meetings, presentations, and deliverable timelines.

Student–Faculty Expectations Agreement

Georgia Tech believes in mutual respect, acknowledgement, and responsibility between faculty and students. The Student–Faculty Expectations Agreement outlines baseline expectations of both parties. Simple respect for knowledge, hard work, and professional conduct builds the research environment we all depend on.

Communication Standards

- Canvas and email are the primary channels for all official course announcements, grade notifications, and instructor-to-student communications. Students are expected to check Canvas regularly and respond to emails within one business day.
- MS Teams: Primary channel for day-to-day research communication, subteam coordination, and meeting collaboration. Students are expected to respond to MS Teams messages within one business day and use the shared folder for all project file management.
- Email: Use for all communications with instructors and TAs. Include the course name and your subteam in the subject line. Expect a response within one business day.
- GitHub: Code must be committed and pushed at minimum once per week. Commit messages must be descriptive (not "update" or "fix").
- Meeting Minutes: Required after each subteam meeting. Stored in the individual user's MS Teams folder. Include: date, attendees, agenda, decisions, and action items with owners and deadlines.

Recording Policy

Full-team and midterm/final presentation sessions are recorded for students who cannot attend synchronously and for peer review. Recordings are stored in the MS Teams SCI channel and are accessible only to enrolled students and SCI team members.

Campus Resources for Students

Undergraduate Academic Success

A comprehensive list of undergraduate academic support resources is available at success.gatech.edu. Drop-in tutoring, PLUS sessions, and one-on-one appointments are available through the Clough Undergraduate Learning Commons, Suite 283 (tutoring@gatech.edu).

Graduate Student Resources

Graduate student academic and professional resources are maintained by the Office of Graduate and Postdoctoral Education. Resources include the Communications Center, Language Institute, Library Research Services, Career Center, and the Graduate Student Resource Guide.

Student Well-Being

Georgia Tech is committed to students' physical, social, and mental well-being. A comprehensive wellness resource list is maintained by the Office of the Vice President for Student Engagement and Well-Being at students.gatech.edu/student-resource-guide. If you are facing challenges affecting your ability to participate in research, please speak with Dr. Tsai or reach out to counseling.gatech.edu. Your research contributions matter, and so does your health.

Key SCI Team Documents (Available on MS Teams)

- VIP Student and Mentor Guide (2023, v1.3) — Research approaches, SMART goals, documentation standards, meeting minutes format, and MS Teams folder structure
- VIP Student Grading Template — Seven-category rubric with performance benchmarks for Good / Medium Good / Medium Poor / Poor; used for midterm and final evaluations
- Presentation Templates — 5-minute (quick overview) and 10-minute (detailed) slide templates in SCI format
- Example Past Presentations — Representative student presentations from prior semesters for reference
- Confidentiality Agreement — Must be signed before accessing shared data or sponsor materials

- VIP Team Folder Structure Reference — Example of correctly organized Code / Data / Documentation / Literature / Presentations / User folder hierarchy
- Publication Target List — Updated each semester with recommended journals and conferences by research area

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Smart City Infrastructure Research Group · Georgia Institute of Technology

Syllabus prepared April 13, 2026 · Submit to syllabus.gatech.edu before first day of class