Carnegie Mellon University

Fall 2020 Mini II: 94-845/12-645

Smart Cities: Growth with **Intelligent Transportation Systems**

Lecture: Tuesday, 6:40pm–9:30pm, Virtual Zoom

This course was designed and modified over time for a completely remote context.

Instructor:

Sean Qian
Henry Posner, Anne Molloy, and Robert and Christine Pietrandrea Associate Professor,
Department of Civil and Environmental Engineering and H. John Heinz III College
seanqian@cmu.edu, Zoomly available
Office hours: Fridays, 11-noon (pre-registration required, starting from Nov 6) or by appointment

Stan Caldwell
Executive Director, Traffic 21 Institute and Mobility21 National University Transportation Center
Adjunct Associate Professor for Transportation and Policy, H. John Heinz III College
stancaldwell@cmu.edu

TA:

Rick Grahn
Doctoral candidate, Department of Civil and Environmental Engineering
rgrahn@andrew.cmu.edu Zoomly available
TA office hours will be announced later on Canvas

Canvas

Canvas organizes this course. All course materials will be posted to Canvas (www.cmu.edu/canvas)
Zoom online lectures: links are available upon logging onto Canvas

Class recordings and privacy:
Class recordings are for the use of this particular smart cities course and for students who enrolled in this class ONLY. They must not to be shared via any publicly available site. They will be shared by the instructor on Canvas ONLY. Guest lectures may not be recorded.

Office Hours:

Prof. Sean Qian holds weekly Office Hours: Fridays, 11-noon, from Oct 30, 2020 to Dec 4, 2020.

Zoom online Office Hours: links are available upon logging onto Canvas. Pre-registration is **required** for office hours. You will be placed in a waiting room and admitted to main sessions by the order of presence.

Student well-being:

This semester is unlike any other. We are all under a lot of stress and uncertainty at this time. Attending Zoom classes all day or even atypical in-person classes can take its toll on our mental health. Make sure to move regularly, eat well, and reach out to your support system or the instructor (seanqian@cmu.edu) if you need to. We can all benefit from support in times of stress, and this semester is no exception.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website thttp://www.cmu.edu/counseling/. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

Diversity and Inclusion:

We must treat every individual with respect. We are diverse in many ways, and this diversity is fundamental to building and maintaining an equitable and inclusive campus community. Diversity can refer to multiple ways that we identify ourselves, including but not limited to race, color, national origin, language, sex, disability, age, sexual orientation, gender identity, religion, creed, ancestry, belief, veteran status, or genetic information. Each of these diverse identities, along with many others not mentioned here, shape the perspectives our students, faculty, and staff bring to our campus. We, at CMU, will work to promote diversity, equity and inclusion not only because diversity fuels excellence and innovation, but because we want to pursue justice. We acknowledge our imperfections while we also fully commit to the work, inside and outside of our classrooms, of building and sustaining a campus community that increasingly embraces these core values.

Each of us is responsible for creating a safer, more inclusive environment. Unfortunately, incidents of bias or discrimination do occur, whether intentional or unintentional. They contribute to creating an unwelcoming environment for individuals and groups at the university. Therefore, the university encourages anyone who experiences or observes unfair or hostile treatment on the basis of identity to speak out for justice and support, within the moment of the incident or after the incident has passed. Anyone can share these experiences using the following resources:

• Center for Student Diversity and Inclusion: csdi@andrew.cmu.edu, (412) 268-2150
• Report-It online anonymous reporting platform: reportit.net username: tartans password: Plaid

All reports will be documented and deliberated to determine if there should be any following actions. Regardless of incident type, the university will use all shared experiences to transform our campus climate to be more equitable and just.

Course Context

Cities all around the world are being built and re-invented as smart cities utilizing information systems and innovative applications of data analytics. One major smart cities component is transportation. The Intelligent Transportation Systems (ITS) industry is expected to grow at a rate of 9% per year and reach $45 Billion in annual investment by 2023 (Greenenergy24, 2017). This shifting dynamic provides great opportunity for improved transportation safety and efficiency but also poses challenging information systems and public policy challenges. Furthermore, there are new opportunities for professional-school graduates outside of engineering schools for employment in transportation planning and policy.

This course is supported by CMU's Traffic21 Institute Mobility21 National University Transportation Center. Classes will feature guest lectures provided by Traffic21/Mobility21 faculty and industry and government ITS professionals.

Course Objectives

- Develop an understanding of the underlying dynamics of the smart cities trend and how ITS is integrated. Smart Cities components in addition to transportation include; energy systems, health and human services, education, water and sewer infrastructure, public safety, etc.

- Develop an understanding of the various components of ITS. Examples of ITS components included; autonomous and connected vehicle technology in vehicles and between infrastructure and vehicles, real-time sensing of infrastructure, artificial intelligence to analyze data, information dissemination, shared mobility services, etc.

- Develop an understanding of the various applications/systems of ITS on the local, state, national and international levels. Examples of ITS applications include: advanced traffic control system, automatic road enforcement (variable speed limits, electric toll collection), intelligent public transportation system, transportation demand management, intelligent parking management system, multi-modal traveler information systems, etc.

- Synthesize and analyze ITS policy and understand the technology challenges. Examples of current technology challenges include inadequacy of GPS positioning distribution of safety certificates. Policy challenges include; privacy, liability, tax equity, social acceptance of technology, etc.

- Develop hands on experience of ITS concepts by applying them to scenarios such as the City of Pittsburgh's smart transportation plans.

Course Format

Each of the class meetings will focus on a particular topic of ITS. To pursue the course objectives most effectively you will be asked to accomplish the following:

1) Read the assigned article(s) or technical report(s) in advance,
2) Attend guest lectures provided by the instructors, industry and government ITS professionals,
3) Participate in the discussion for ITS issues and case studies,
4) Prepare weekly reflections after each class and turn in by Monday midnight,
5) Hand in a final project report and present your project in the end of the course.

Grading:

Your course grade will be based on the following team and individual activities and weights:

Team:

Final Project (proposal due 11/20 accounts for 10%)   50%

Individual:

Five Weekly Reflections (Due on Monday by Midnight)   40%
Class Participation   10%

Total: 100%

Textbook

There is no textbook for this course. Materials will be posted on Canvas as needed.

Final Project

All students will be expected to complete a semester project on a topic of their choice in transportation systems. Because I am convinced that you can learn a great deal in this course by working with your fellow students, you are encouraged to work in teams of three or four. Each group would need at least one engineer (or computer scientist) and one policy analyst (or social scientist). For those of you that have trouble selecting a topic, we will brainstorm some ideas in class. In the meantime, you might begin to consider potential topics and groups. Expectations on the project work will change based on the number of group members. Groups will present oral summaries of their work during the last class session and will submit written reports. Each group member will need to present his/her work as part of the group presentation.

Your group may choose to do an in-depth project on any of the above applications. Your group may also develop your own project. A project report is to be submitted by Dec 11. The project must

include both technology and policy components. Please work closely with the instructors and the TA to develop your project ideas if needed.

Possible project topics include, but are not limited to:
- A critical review of an ITS application with proposed future research framework
- Cost/benefit analysis of an ITS component or application
- A state-of-the-art review of an ITS component or application, and its future development
- How can an ITS component or application be implemented to achieve sustainable mobility?
- How can an ITS component or application help to manage transportation demand efficiently (e.g., congestion pricing, parking pricing)?
- How does an ITS component or application affect the long-term land-use development, urbanization or transit-oriented development?
- Data Analytics and its applications in an ITS.

Appearing below is the grade sheet that will be completed for each project. Make sure your project has all the elements listed.

Item	Possible	Score
Oral Presentation	10	
Statement of Problem/Goal/Background	4	
Literature Review	4	
Research Approach	2	
Analysis	7	
Results	7	
Conclusions	4	
Limitation and Future Work	2	
Total	40	

A one-pager project proposal is due Nov 20 5pm. The proposal accounts for 20% of the final project, namely 10% of the course grade. The proposal should have the following elements:

Item	Possible	Score
Statement of Problem/Goal/Background	2	
Expected Research Approach	2	
Expected Results/Outcomes	2	
A list of potential readings and/or data sets	2	
Task description for each group member	2	
Total	10	

COURSE CALENDAR

MODULE 1: Why Smart Cities, Why ITS, Why Now?

10/27   Course overview, Smart Cities overview (6:40-7:10)
         Guest lecture and Q&A (7:20- 8:20)
         Lecture and discussions: Smart cities; Rights-of-way permitting systems (8:30-9:15)
         Introduction to intelligent sensing (9:20-9:30)

   -       Guest Speaker: Karen Lightman (CMU Metro21 Institute)

MODULE 2: Technology in ITS

11/03   Intelligent sensing

         Guest lecture and Q&A (6:40- 7:40)
         Lecture: Intelligent sensing (7:50-8:50)
         Discussions: Opportunities and challenges of smart sensing (9:00-9:20)
         Introduction to connected vehicles (9:20-9:30)

   -       Guest Speaker: Christoph Mertz (RoadBotics)

11/10   Autonomous and Connected Vehicles, applications of V2I and V2V

         Lecture: Connected automated vehicles (6:40- 7:50)
         Lecture: Intelligent sensing (8:00-9:00)
         Discussions: The future of autonomous vehicles (9:00-9:20)
         Introduction to demand management (9:20-9:30)

   -       Speaker: Stan Caldwell (CMU Traffic21 Institute)

MODULE 3: Applications of ITS that bring intelligence to the travelers and managers

11/17   Travel Demand Management and Traveler Information Systems

         Guest lecture and Q&A (6:40- 7:40)
         Lecture: Travel demand management (7:50-8:50)
         Discussions: ITS and demand management; TDM for Philadelphia downtown (9:00-9:20)
         Introduction to transportation data analytics (9:20-9:30)

   -       Guest Speaker: Naveen Lamba (Grant Thornton)

11/20   Term project one pager proposal due 5pm

11/24   Data Analytics, System Modeling; Shared Mobility Services

Guest lecture and Q&A (6:40- 7:40)
Lecture: Transportation system modeling and data analytics (7:50- 8:50)
Discussions: Shared mobility and data; Transportation solutions for CMU (9:00-9:20)
Introduction to traffic control systems (9:20-9:30)

-       Guest Speaker: Alex Pazuchanics (City of Seattle)

12/01   Adaptive Traffic Signalization

Guest lecture and Q&A (6:40- 7:40)
Lecture: Traffic control systems (7:50-8:50)
Discussions: Travel behavior and Traffic control systems (9:00-9:30)
Final project Q&A (9:30 -)

-       Guest Speaker: Steve Smith (CMU RI)

MODULE 4: Project presentations

12/08 Term project presentations (6:40-9:30) **(may be extended depending on the number of teams)**

12/11 Term project report due midnight