ECE 4390/CRN 25862, ECE 5390/CRN 25869
Transportation Cyber-Physical Systems

Spring 2025

Actuated intersection

Public transport system

Air traffic control

Course meeting time: MW 1:30 – 2:50 pm @ Chemistry Computer Sci Bldg 1.0204
Credits: 3
Course website: MY UTEP ⟶ Blackboard

1 Instructor

Dr. Shi'an Wang (swang14@utep.edu)
Office: Engineering Building, A-316
Office hours: M 4:30–5:30 pm; T 4:00–5:00 pm; W 4:30–5:30 pm, or by appointment

I received a PhD in 2022 and MS in 2018 from the University of Minnesota and University of Ottawa, respectively. I first started teaching at The University of Texas at El Paso in Fall 2023.

2 Course description

Welcome to ECE 4390/5390! This is a cross-listed course open to both undergraduate and graduate students. The course provides a comprehensive introduction to the methods behind cyber-physical systems (CPS), focusing on applications in the transportation domain, specifically transportation cyber-physical systems (T-CPS). Topics include systems theory, data-driven CPS methods, security and privacy, and emerging frontiers. Upon completing this course, you will: (i) gain an understanding of what CPS are and how they relate to civil infrastructure and intelligent transportation systems, (ii) learn the fundamentals of systems theory necessary to understand T-CPS within a systems-theoretic framework, and (iii) learn how to apply data-driven methods from CPS to transportation-related problems.

3 Course format

While this course primarily follows a lecture-based learning format, I will also introduce both numerical and practical T-CPS problems during the lectures. The goal is for you to learn about

emerging technologies for next-generation intelligent transportation systems, in addition to fundamental concepts of CPS methods. Every student is expected to participate in class discussions of problems and solutions. Active engagement with problems in class has been shown to enhance learning and retention[1].

3.1 Prerequisites

While there is no mandatory prerequisite for taking this course, you may find it helpful to review Linear Algebra before the semester gets too busy, especially if it has been some time since you last took these classes. We will also spend a good amount of time reviewing the relevant concepts of Linear Algebra necessary for this course in the early stages of the class.

3.2 Communication

Please feel free to drop in during my office hours without prior notice; that is the purpose of office hours. If you cannot make it to office hours, feel free to email me to set up an alternative appointment time. Also, feel free to ask questions via email. I will try to respond to all emails within one business day.

4 Assessment

Grades will be determined by performance on the following items. Requests for regrading must be submitted within one week of when grades are posted.

Category	Weight
Homework (every 1–2 weeks)	50%
Final project	40%
Participation	10%

- **Homework (50%)**
  - Assigned (roughly) every two weeks.
  - Homework consists readings and associated responses.
  - Homework is intended to provide an understanding of CPS.
- **Final Project (40%)**
  Option #1
  - Detailed presentation of a T-CPS paper of your choice to the class.
  - Present the paper in the context of topics discussed in class.

  Option #2 (≤ 2 students per team, recommended for graduate students)
  - Work with Dr. Wang to identify an interesting research question early in the semester.

[1] Deslauriers, L., McCarty, L., Miller, K., Callaghan, K., & Kestin, G. (2019) Measuring actual learning versus feeling of learning in response to being actively engaged in the classroom. *Proceedings of the National Academy of Sciences*, 116 (39), 19251–19257.

  - Work with Dr. Wang to address the research question and present the results in class.

- **Participation (10%)**
  - Participation is expected from all students.
  - Class attendance and participation in active class discussion.

The A–F grading scale will be used. Cutoffs for letter grades will be determined at the end of the semester. Please feel free to contact me at any time during the semester to discuss your progress to date.
Homework will be posted on Blackboard. Late submissions will be penalized by 30% (maximum score 70%), and will only be accepted up to one week late. When submitting files online, students are responsible for ensuring that the submitted files are uploaded correctly. The instructor cannot give credit for corrupt or irrelevant files, and the standard late penalty will be applied when correct files are uploaded after the deadline.
Guidance on Artificial Intelligence (AI): Use of AI technologies or automated tools, particularly generative AI such as ChatGPT or DALL-E, is *not* allowed for assignments in this class. Each student is expected to use critical and creative thinking skills to complete tasks and not rely on computer-generated ideas. Any direct use of AI-generated materials submitted as your own work will be treated as plagiarism and reported to the Office of Student Conduct and Conflict Resolution.

5 Schedule

A tentative class schedule is shown below, but dates and topics may change.

1/22 **1** Orientation; introduction to systems theory	1/27 **2** Introduction to systems theory
1/29 **3** State space, control, estimation and filtering	2/3 **4** State space, control, estimation and filtering
2/5 **5** Linear algebra review and systems	2/10 **6** Linear algebra review and systems
2/12 **7** Linear algebra review and systems	2/17 **8** Traffic estimation and filtering
2/19 **9** Traffic estimation and filtering	2/24 **10** Microscopic traffic modeling, data collection, mixed autonomy traffic impacts
2/26 **11** Microscopic traffic modeling, data collection, mixed autonomy traffic impacts	3/3 **12** Control of mixed autonomy traffic, autonomous vehicles and sensors
3/5 **13** Control of mixed autonomy traffic, autonomous vehicles and sensors	3/10 **14** Spring Break
3/12 **15** Spring Break	3/17 **16** Introduction to neural networks and machine learning
3/19 **17** Introduction to neural networks and machine learning	3/24 **18** Unsupervised learning
3/26 **19** Unsupervised learning	3/31 **20** Supervised learning
4/2 **21** Supervised learning	4/7 **22** Reinforcement learning
4/9 **23** Reinforcement learning	4/14 **24** CPS security and differential privacy
4/16 **25** CPS security and differential privacy	4/21 **26** Rail CPS and T-CPS in aviation
4/23 **27** Rail CPS and T-CPS in aviation	4/28 **28** Urban sensor networks
4/30 **29** Urban sensor networks	5/5 **30** Urban sensor networks
5/7 **31** Urban sensor networks	5/14 **Final exam** 4:00–6:45 pm **Presentation** (UTEP scheduled time)

6 Miscellania

ABET is the external accreditation organization for all engineering programs in the United States. ABET requires documented student outcomes that prepare graduates to attain the program educational objectives. EE 4364 explicitly addresses three of these seven student outcomes.

- Criterion 1 – An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science and mathematics.
- Criterion 4 – An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- Criterion 5 – An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Policy statements

- University-wide final examination schedules: Final Examination Schedules
- Administrative Policy: Policies and Regulations
- Attendance and Grading: Policies and Regulations: Attendance and Grading
- Scholastic Integrity: Academic Dishonesty Violations and HOOP: Student Conduct and Discipline
- Student Conduct: Student Conduct
- Board of Regents Policy: Equal Opportunity
- Student Support: Center for Accommodations and Support Services (CASS)
- Board of Regents Policy: Academic Freedom and Responsibility
- My goal is to create a learning environment that is accessible and inclusive for all students. If you anticipate any barriers related to the design of the course, e.g., format, materials, or structure, please contact me outside of class so we can explore potential options. If you have a disability and want to explore formal accommodations and/or further resources, please register with the UTEP Center for Accommodations and Support Services (CASS). Contact CASS at 915-747-5148, email them at cass@utep.edu, or apply for accommodations online via the CASS portal. If you have already consulted with the CASS, please share your letter with me as soon as you can to discuss how your accommodations will be implemented in this course.