Department of
Civil & Environmental Engineering
THE UNIVERSITY OF UTAH

CVEEN 6592

AI-Enabled Electrified Transportation

Course Handouts



Chenxi Liu

University of Utah

Fall 2026

Course Syllabus

Class:	CVEEN 6592: AI-Enabled Electrified Transportation (Online, asynchronous)
Time:	Asynchronous throughout. Each weekly module opens on Monday and its assignment is due the following Sunday at 11:59 PM MT, and you choose when inside that window to work.
Location:	Online, through the course website
Website:	The course website. The address is announced before the first week.
Enrollment Requirement:	3 credit hours. Graduate standing, open to students in any program. The course builds on college-level mathematics and comfort with quantitative reasoning, and it teaches Python from the beginning in Module 2, so students arriving from any background can take it.
Objective & Outcomes	CVEEN 6592 develops the ability to model an electrified transportation system, to apply artificial intelligence and machine learning to it, and to place the result inside the policy system it will actually operate in. The material is organized into four modules: foundations of electrified transportation systems, modeling electrified transportation, AI and machine learning applications, and integration and policy-aware design. By the end of the course, students will be able to (1) identify the components of an electrified transportation system and their interdependencies, and analyze current adoption and infrastructure trends from data; (2) apply travel behavior and demand modeling concepts, and interpret electric vehicle energy, range, and charging profiles; (3) build, calibrate, and interrogate models of electrified transportation in Python, including agent-based simulation, mathematical optimization, and integrated multimodal system models; (4) formulate a transportation problem as a supervised, unsupervised, or reinforcement learning task, engineer features for it, and train and evaluate a model honestly against an appropriate baseline; (5) map an electrified transportation system, identify its feedback loops, trade-offs, and stakeholders, and evaluate a real policy against equity, environmental justice, and grid resilience criteria; and (6) carry an analysis from data through model to a defensible recommendation, and communicate it to a technical and a non-technical audience.
Description:	Electric vehicles are entering the transportation system faster than the infrastructure that serves them, and the resulting problems cut across vehicle technology, travel behavior, the electrical grid, and public policy at once. Charging demand is a behavioral question that lands on the electrical grid; charger siting is an optimization problem with an equity consequence; a demand forecast is only useful if somebody can act on it. This course treats that system as a whole and builds the quantitative tools to reason about it. The course is a graduate-level applied modeling course. Methods are introduced in a consistent sequence: the phenomenon first, then the model that represents it, then the code that runs it, then an honest evaluation of what the model supports and where its limits lie. Python is taught from zero in Module 2, so the course is open to students from any background, and every technical week ends with a hands-on assignment on real electric vehicle data. The course is delivered fully online and asynchronously, so you work through

	each week on your own schedule. Each week is a self-contained module on the course website containing recorded video lectures, required readings and multimedia, and one graded assignment. The semester closes with a final project, submitted through the course website as a recorded presentation and a written report.	
Instructor:	Chenxi Liu	
	Office: Office hours: Phone:	2032 MCE Tuesdays 2:00 to 2:50 p.m., and by appointment through the course website (801) 585-0476 E-mail: chenxi.liu@utah.edu
Grading Policy:	Weekly Assignments (14 × 5%): 70%; Final Project: 30%	

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CVEEN 6592: AI-Enabled Electrified Transportation

Course Schedule – Fall 2026

Week	Module	Dates	Topic and Content	Assignment Due
1	1	Aug. 24 – 30	Introduction and Systems Overview. Components of an electrified transportation system; EV market trends and adoption barriers; stakeholders; the scope of modeling needs; AI applications in transportation	Assignment 1 due Sun., Aug. 30
2	1	Aug. 31 – Sep. 6	Travel Behavior and Demand Modeling. Individual behavior and aggregate demand; travel survey and passively collected data; OD matrices, peak hour factors, and temporal and spatial patterns	Assignment 2 due Sun., Sep. 6
3	1	Sep. 7 – 13	EV Characteristics and Charging Behavior. Battery capacity, energy consumption, and range; charging levels and charging curves; where and when drivers charge; heterogeneity and the agent-based idea	Assignment 3 due Sun., Sep. 13
4	2	Sep. 14 – 20	Python Foundations for Electrified Transportation Modeling. Anaconda and Jupyter; NumPy arrays and vectorization; pandas for loading, filtering, grouping, and resampling; data cleaning; a first Matplotlib chart	Assignment 4 due Sun., Sep. 20
5	2	Sep. 21 – 27	Modeling Charging Demand and Behavior. The charging load curve; why averages hide the peak; agent-based modeling in Mesa; calibration against observed data with MAE and RMSE; what-if experiments	Assignment 5 due Sun., Sep. 27
6	2	Sep. 28 – Oct. 4	Planning Electric Bus Deployment. Range, depot charging, dwell time, and budget as constraints; decision variables, objective, and constraints; integer programming in PuLP; reading a solver's answer and building a phased plan	Assignment 6 due Sun., Oct. 4
7	2	Oct. 5 – 9	Integrated Electrified Mobility Modeling. Multimodal systems and the first-mile last-mile gap; GTFS and GBFS; four-step and activity-based models; mode choice; systems thinking and feedback loops; a six-layer conceptual model	Assignment 7 due Mon., Oct. 19, after Fall Break
—	—	Oct. 10 – 18	Fall Break. The semester resumes Monday, Oct. 19	

8	3	Oct. 19 – 25	Fundamentals of AI and ML for Transportation. Supervised, unsupervised, and reinforcement learning; classification and regression; the five-step scikit-learn workflow; train-test split, pipelines, and reading a score against a baseline	Assignment 8 due Sun., Oct. 25
9	3	Oct. 26 – Nov. 1	Data Analytics and Feature Engineering. Exploratory analysis and cleaning; encoding and scaling; temporal features including cyclical time; spatial features from coordinates; feature importance and principal component analysis	Assignment 9 due Sun., Nov. 1
10	3	Nov. 2 – 8	Demand and Charging Prediction with ML. Time-series data and chronological splitting; neural networks, RNNs, and LSTMs; PyTorch tensors, autograd, and the training loop; an honest comparison against a baseline	Assignment 10 due Sun., Nov. 8
11	3	Nov. 9 – 15	AI for System Optimization. The agent-environment loop of states, actions, and rewards; exploration versus exploitation; Q-learning and the Bellman update; training a route optimizer; simulators for reinforcement learning	Assignment 11 due Sun., Nov. 15
12	3	Nov. 16 – 22	Multi-Agent Systems for Complex Problems. AI agents, coordination, and centralized versus decentralized architectures; multi-agent reinforcement learning and non-stationarity; building an EV charging network simulation in Mesa; emergent behavior	Assignment 12 due Sun., Nov. 22
13	4	Nov. 23 – 29	Systems Thinking and Policy-Aware Design. System maps, reinforcing and balancing feedback loops, trade-offs, and stakeholders; three real projects read through the same lens; where AI fits in a policy system. Thanksgiving Break falls on Nov. 26 – 29	Assignment 13 due Mon., Nov. 30
14	4	Nov. 30 – Dec. 6	Policy Brief and AI Ethics. The policy brief as a document type; four families of electrification policy; energy justice and grid resilience; privacy, bias, accountability, and transparency in public systems	Assignment 14 due Sun., Dec. 6
15	4	Dec. 7 – 13	Final Project. The week is reserved for completing the report and recording the presentation. Last day of classes is Thu., Dec. 10	Final project report and recorded presentation due Sun., Dec. 13

Note: Each weekly module opens on Monday and closes with its assignment on the following Sunday at 11:59 PM MT. Both University breaks are kept clear of deadlines: the Week 7 assignment is due Monday, Oct. 19, after Fall Break, and the Week 13 assignment is due Monday, Nov. 30, after Thanksgiving Break. The syllabus is not a binding legal contract. The instructor may modify it when the student is given reasonable notice of the modification.

CVEEN 6592 Course Expectations and Policy

Expectations for Course Work

How This Online Course Works

This course is delivered fully online and asynchronously, so you set your own hours inside each week. The material is organized into four modules and fifteen weekly modules on the course website. Module 1, Foundations of Electrified Transportation Systems, runs three weeks. Module 2, Modeling Electrified Transportation, runs four weeks and teaches Python from the beginning. Module 3, AI and Machine Learning Applications, runs five weeks. Module 4, Integration, Policy-Aware Design, and Projects, runs the final three weeks.

Each weekly module opens on Monday and contains four things: the recorded video lectures for that week, the required readings, the required multimedia, and one graded assignment due the following Sunday at 11:59 PM MT. Work through them in that order: the lectures are written to be self-contained, and the assignment assumes you have done both the lectures and the readings.

Two University breaks fall inside the semester, and both are kept clear of deadlines. Fall Break runs Oct. 10 – 18, and the semester resumes on Monday, Oct. 19, which is also when the Week 7 assignment is due. Thanksgiving Break runs Nov. 26 – 29, inside Week 13, so the Week 13 assignment is likewise due on the Monday the break ends.

Video Lectures

The recorded video lectures carry the primary instruction in this course. Each week's lectures are released with that week's module and remain available for the rest of the semester. They are the only place where the derivations are worked, the code is read line by line, and the reasoning behind each modeling choice is given, so the assignments are written on the assumption that you have watched them.

Required Readings and Multimedia

Every week has required readings and required multimedia listed in that week's module. They are assessed through the assignments and the final project, which draw on them directly. The readings supply the domain context the lectures compress, and several assignments ask you to cite them.

Weekly Assignments

There are fourteen weekly assignments, one for each of Weeks 1 through 14, each worth 125 points. They are individual efforts as described in CVEEN Homework Assignments: Process of Solution and Formatting Requirements (effective 9/1/2004):

“The completed homework assignments that you turn in for credit must be substantially your own work. It is permissible to discuss the basic concepts and how to solve the problem in a general sense with other students, but the actual assignment must be your own. Also, you must sign the following pledge on every assignment you turn in for credit:

On my honor as a student at the University of Utah, I have neither given nor received unauthorized aid on this assignment.

If the pledge is missing or is not signed, the assignment will not be graded.”

Assignments are submitted through the course website and are due by 11:59 PM MT on the due date. The assignments in Modules 2 and 3 require a Python or R script or a Jupyter notebook in addition to a written report; the assignments in Modules 1 and 4 are written analyses with figures. Each assignment specifies its deliverables and carries its own rubric on the course website. File naming follows the pattern LastName_Assignment_WeekN and LastName_Report_WeekN.

Final Project

The final project asks each team to apply the methods of this course to a real problem in AI-enabled electrified transportation. Topics typically fall into one of four directions: simulation of an EV charging network under varied demand or pricing conditions; optimization of bus fleet electrification and charging scheduling; machine-learning prediction of travel or charging demand; or a policy-driven scenario analysis linking AI insights to equitable infrastructure planning. A project should state a clear research question, identify its data sources, describe its methods, and report its findings.

There are four deliverables, all uploaded to the course website by the deadline. A recorded video presentation of about ten minutes, in which the team presents the project over its own slides; record it with any screen capture tool and upload the file or a link. A technical report of about ten pages covering methods, code, assumptions, results, and discussion. An executive summary of about one page written for a non-technical stakeholder audience. And the slide file itself. The recording is the whole presentation, so it has to stand on its own for a viewer watching it later.

The project is graded on integration of concepts, technical accuracy and rigor, application of AI and modeling, policy and societal relevance, communication in both the report and the recording, team collaboration, and creativity and reflection. Team formation and topic approval are arranged through the course website. At the end of the semester a peer evaluation is conducted, in which team members allocate 100 points among their peers based on individual contributions.

College of Engineering Guideline

The College of Engineering Semester Guidelines contain important dates regarding adding, dropping and withdrawing from classes as well as the College Policy regarding repeating courses. For this semester-length class the last day to add, drop, or audit is Friday, September 4, 2026, and the last day to withdraw and elect CR/NC is Friday, November 13, 2026.

Please refer to the details here: https://www.coe.utah.edu/students/current/semester-guidelines/

Accessibility

The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations. (www.hr.utah.edu/oeo/ada/guide/faculty/)

Professional Responsibilities

Students should read the “Student Code” (Policy 6-400: Code of Student Rights and Responsibilities) carefully and know they are responsible for the content. The Policy is located at the following link: http://www.regulations.utah.edu/academics/6-400.html

All students are expected to maintain professional behavior in the classroom setting. Students have specific rights in the classroom, detailed in Section II of the Student Code. The Student Code also specifies academic

misconduct, including, but not limited to, cheating, misrepresenting one's work, inappropriately collaborating, plagiarism, and fabrication or falsification of information. The process for resolving any violations of the Student Code, including academic sanctions, is also described.

Course Policies

Participation.

This course is fully asynchronous, and you work through each week on your own schedule inside the weekly deadlines. Your grade is determined entirely by the work you submit.

Academic Integrity Policy

You are expected to uphold the highest standards of academic honesty in all your work. Any form of academic misconduct, such as cheating, copying, or plagiarism, will not be tolerated. Misconduct includes, but is not limited to, the following:

- Copying from another student's work or allowing your work to be copied.
- Submitting someone else's work as your own, or using AI tools or external resources in a manner not permitted under the Collaboration and Use of AI Tools policy below.
- Fabricating data or results, or reporting results that were not produced by the analysis you submitted.

Consequences for Violations:

- First Incident: If you are found to have engaged in academic misconduct on any assignment or on the final project, you will receive a zero for that specific task.
- Second Incident: Any subsequent incident of academic misconduct will result in a failing grade for the entire course.

These incidents will be reported to the Office of Student Conduct, which may lead to further actions according to university policies. Submissions are run through TurnItIn.

Collaboration and Use of AI Tools

Generative AI tools may be used in the assignments and the final project. Professional engineering practice increasingly involves these tools, and the aim of this course is to develop competent and accountable use rather than to prohibit use. Two conditions apply. First, you remain fully responsible for everything you submit and must be able to explain any calculation, assumption, or argument in your work. Second, submissions must include a brief statement of which AI tools were used and for what purpose.

Late Turn-ins.

You are required to turn in your assignments on time. Late turn-ins can be accepted within seven days after the due date but will be discounted at 10% per day it is late. For example, if an assignment is due on Sep. 20 and you turn it in on Sep. 22, it would amount to a deduction of 20% for this two-day late assignment. If you turn in on Sep. 28 or after, it will not be accepted, and no credit will be given. Final project materials are not accepted late, and no credit is given for any part of the project submitted after the due date.

Final Grade Determination.

Your final grade is determined by combining your scores on the fourteen weekly assignments and the final project using the following weights:

- Weekly Assignments (14 × 5%): 70%
- Final Project: 30%

Each weekly assignment is worth 125 points and each contributes equally. The final project grade is adjusted by the peer evaluation described above.

Letter	Scoring	Qualitative Description
A	100% - 92.5%	No to minor mistakes.
A-	92.49% - 90%	
B+	89.99% - 87.5%	
B	87.49% - 82.5%	
B-	82.49% - 80%	Several minor mistakes; almost no conceptual mistakes.
C+	79.99% - 77.5%	
C	77.49% - 72.5%	
C-	72.49% - 70%	Several mistakes, some major; conceptual mistakes.
D+	69.99% - 67.5%	
D	67.49% - 62.5%	
D-	62.49% - 60%	Many significant mistakes and conceptual errors.
E	59.99% - 0	Non-response or completely incorrect response.