Course Syllabus

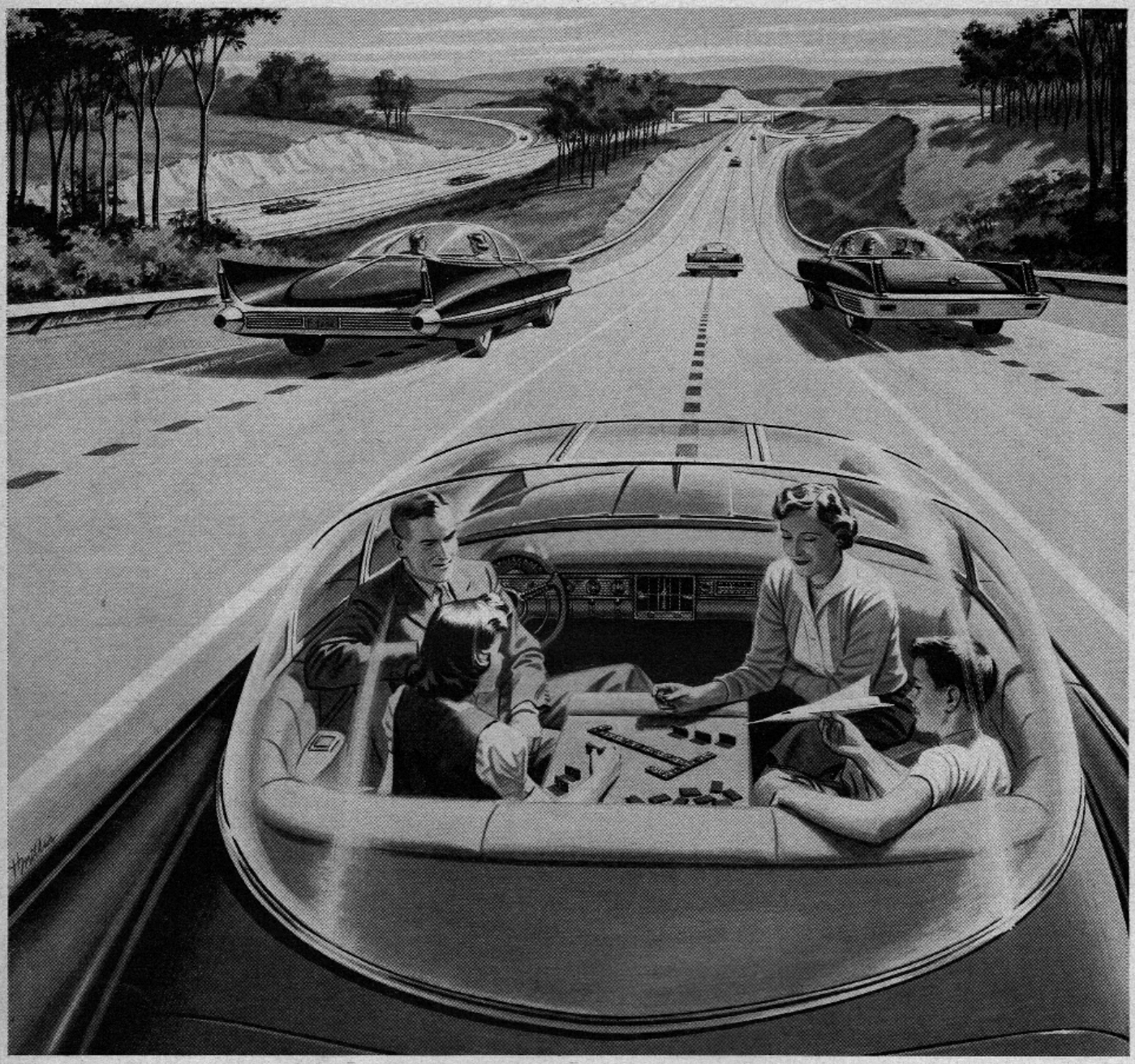
EN 560.651 (451): Smart Transportation & Autonomous Vehicles

Spring, 2026

Instructor: Dr. Frank (Hao) Yang, haofrankyang@jhu.edu (mailto:haofrankyang@jhu.edu)

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(mailto:yzhao229@jh.edu) (mailto:haofrankyang@jhu.edu) (mailto:haofrankyang@jhu.edu) (mailto:haofrankyang@jhu.edu) Class Hours: T Th 09:00 AM - 10:15 AM
Class Room: Hodson Hall 203, Homewood
Office Hours: Every Thursday 10:20-12:00pm
Office: Latrobe Hall 201 N



ELECTRICITY MAY BE THE DRIVER. One day your car may speed along an electric super-highway, its speed and steering automatically controlled by electronic devices embedded in the road. Travel will be more enjoyable. Highways will be made safe—by electricity! No traffic jams . . . no collisions . . . no driver fatigue.

POWER COMPANIES BUILD FOR YOUR NEW ELECTRIC LIVING

Your air conditioner, television and other appliances are just the beginning of a new electric age.

Your food will cook in seconds instead of hours. Electricity will close your windows at the first drop of rain. Lamps will cut on and off automatically to fit the lighting needs in your rooms. Television "screens" will hang on the walls. An electric heat pump will use outside air to cool your house in summer, heat it in winter.

You will need and have much more electricity than you have today. Right now America's more than 400 independent electric light and power companies are planning and building to have twice as much electricity for you by 1965. These companies can have this power ready when you need it because they don't have to wait for an act of Congress—or for a cent of tax money—to build the plants.

The same experience, imagination and enterprise that electrified the nation in a single lifetime are at work shaping your electric future. That's why in the years to come, as in the past, you will benefit *most* when you are served by independent companies like the ones bringing you this message—America's Electric Light and Power Companies*.

*Names on request from this magazine

Self-Drive Cars and You: A History Longer than You Think (Look Ma, no hands: Driverless cars concepts from the 1950s and ’60s from GraphicaArtis/Getty Image).



Waymo is forging ahead with fully autonomous taxi rides in multiple cities. [Jason Henry/AFP via Getty Images (https://www.gettyimages.com/detail/news-photo/waymo-autonomous-vehicle-on-cesar-chavez-street-in-san-news-photo/1788127454?adppopup=true)]

1. Course Description

This course provides a comprehensive overview of the history, evolution, and core technologies driving the transformation of modern transportation systems and autonomous vehicle (AV) deployment. Beginning with a historical perspective on smart transportation and AV development, the curriculum highlights how emerging innovations have shaped today’s connected and automated mobility landscape.

- **1. History and Key Technologies of Smart Transportation and Autonomous Vehicles.** Students will review the evolution of Intelligent Transportation Systems (ITS), explore foundational breakthroughs in automation and vehicle connectivity, and examine current trends influencing future

mobility. Emphasis is placed on real-world milestones and the interplay between technology and policy that accelerates autonomous vehicle adoption.

- **2. Sensing Technology and Data Processing with Machine Learning.** Building on fundamental transportation concepts, the course delves into sensor technologies—such as LiDAR, radar, cameras, and inductive loops—and explains how these diverse data sources drive real-time traffic insights. Students will gain hands-on experience with machine learning techniques and data processing pipelines for tasks like congestion prediction, incident detection, and demand modeling.
- **3. Data Quality Control, Bias Evaluation, and Multimodal Data Fusion.** A central theme is the integrity of data used in decision-making. Through case studies and lab exercises, students will learn methods for noise reduction, bias detection and mitigation, and the integration of heterogeneous data streams from multiple sensors (e.g., image, textual, signal). These approaches ensure robust, fair, and reliable analytics in complex urban mobility environments.
- **4. Autonomous Vehicle Key Technologies and Mixed Autonomy.** The course examines sensing, communication, computing, and decision-making frameworks that power AVs in open-world conditions. Students will explore real-time perception architectures, V2X communication protocols, route planning algorithms, and control systems, while also considering the human-machine interface in mixed traffic scenarios that include both human-driven and autonomous vehicles.
- **5. Trustworthy Machine Learning for Smart Transportation.** Finally, students will investigate how to embed trustworthiness into each stage of AV development—from sensor data processing to large-scale fleet management. Topics include transparency, accountability, cybersecurity, and the ethical deployment of AI-driven transportation solutions. By emphasizing best practices in algorithm design and system governance, students will learn to foster public trust and ensure sustainable adoption of autonomous mobility.

2. Required Reading Materials

Course Slides (on Canvas): Comprehensive notes will be provided for each module. Students are \emph{strongly encouraged} to review these materials before each lecture to enhance understanding and participation.

Research Papers and Case Studies: A selection of peer-reviewed articles and conference proceedings will be assigned throughout the semester to illustrate real-world applications of smart transportation and autonomous vehicle technologies. These may include:

- Journal papers from IEEE Transactions on Intelligent Transportation Systems, Transportation Research Part C, IEEE Transactions on Knowledge and Data Engineering...
- Case studies or technical reports from industry consortiums (e.g., SAE, IEEE, ACM)
- Selected conference papers from venues such as Conference on Computer Vision and Pattern Recognition (CVPR), Conference on Neural Information Processing Systems (NeurIPS), International

Conference on Learning Representations (ICLR), Transportation Research Board (TRB) and International Conference on Intelligent Transportation Systems (ITSC).

Textbooks (Recommended, not required):

- Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, MIT Press, 2016. This textbook provides a solid foundation in modern neural network architectures, which will be relevant for advanced machine learning topics covered in the course.
- Machine Learning for Transportation Research and Applications, Wang, Yinhai, Zhiyong Cui, and Ruimin Ke, Springer, 2023. A more transportation-focused resource covering methods and use cases for data science, machine learning, and analytics in transportation systems.
- Online Tutorials and Documentation: Links to online resources (e.g., Python libraries, sensor data repositories, or coding tutorials) will be posted on Canvas: **EN_560_651__451___Smart_Transportation___Autonomous_Vehicles_Spring26.pdf (https://jhu.instructure.com/courses/116742/files/16885661?location=course_syllabus_116742&wrap=1)**

Course Summary:

Date	Details	Due
Mon Feb 23, 2026	**Spring 2026 -- Assignment 1: Traffic Sensing, Database and Data Quality Control** (https://jhu.instructure.com/courses/116742/assignments/1231592)	due by 10pm
Mon Mar 30, 2026	**Spring 2026 -- Assignment 2: Deep Learning Basics, Sequential Learning, Computer Vision, and Representation Learning in ITS** (https://jhu.instructure.com/courses/116742/assignments/1243874)	due by 10pm
Thu Apr 30, 2026	**Spring 2026 -- Assignment 3: Vehicle Perception, Dynamics, and Control** (https://jhu.instructure.com/courses/116742/assignments/1261610)	due by 10pm
Mon May 11, 2026	**Course Paper** (https://jhu.instructure.com/courses/116742/assignments/1261649)	due by 10pm