CEGE 3201: Introduction to Transportation Engineering

Spring 2022

Technology and Society theme

1 Instructors

Dr. Michael Levin
Email: mlevin@umn.edu

Course meeting time: T/Th 1:00 PM–1:50 PM, 212 Civil Engineering Building

Lab: (a) Th 2:30 PM – 3:20 PM, 221 Civil Engineering Building
(b) Th 4:00 PM – 4:50 PM, 221 Civil Engineering Building

Office: 140 Civil Engineering Building
Office hours: M 10–12pm, W 4–5pm, F 3–4pm or by appointment
Course website: https://canvas.umn.edu/courses/193546

Teaching assistant: Te Xu
Email: xutetelove01@gmail.com
Office: 275 Civil Engineering Building
Office hours: W 11:15 AM – 12:15 PM or by appointment

2 Course description

This course is an introduction to solving transportation problems through analysis and design of transportation models. Topics include travel demand modeling, mode choice, network analysis principles, and transit operations; traffic flow principles, level of service, and signal control; and roadway geometric design. After completing this course, you will have a fundamental understanding of transportation system problems and concepts, as well as experience and tools to work with transportation data. This course also emphasizes using prerequisite mathematics, physics, and computer skills for engineering problem-solving.

Technology and society theme Although we take transportation technologies for granted now, when automobile transportation first became widespread it revolutionized how people live and work. Transportation is experiencing a similar upheaval now with the emergence of automated vehicle technologies. This course covers how transportation systems are used and affected by travelers. We will analyze data and construct engineering models that describe how transportation systems behave from multiple perspectives, including the perspectives of individual travelers and the perspective of transportation planning agencies.

Liberal education course Most of us have developed some preconceived notions of transportation systems based on years of using them. Many of us have identified issues with transportation: traffic congestion; inefficient public transit, etc. Part of developing a liberal education is approaching existing aspects of society with a scientific mind. CEGE 3201 provides a rigorous perspective on transportation systems founded on engineering design principles and scientific study of traveler behaviors. For example, traffic congestion is studied in terms of route choices leading to a high concentration of vehicles on certain roads, as well as traffic flow theory for modeling the behavior of traffic congestion and drivers in such traffic. These topics are treated with engineering rigor and mathematical modeling. By studying such engineering, students gain a deeper understanding of transportation systems, and are more prepared to understand their issues and find informed solutions.

3 Course format

Unlike other engineering courses you may have taken, this course will primarily follow a problem-based learning format. I will introduce transportation problems to you during the lecture session. These problems will be solvable using the prerequisite skills (calculus, probability & statistics, kinematics, and programming), and much of the class time will be spent solving these problems. I will also be assigning you realistic transportation problems to solve. In the lecture, I will give you simplified versions so that you can develop concepts, but you will solve more realistic versions for assignments. **The purpose is for you to learn problem-solving skills, not just solution methods.** My goal is for you to develop the concepts of the solution during class, be introduced to relevant computer tools in the lab session, then solve realistic transportation problems as homework. Every student is expected to participate in class discussions of problems and solutions. Active engagement with problems in-class has been shown to increase learning and retention[1].

3.1 Co-requisites

The co-requisites for this course are CEGE 3101, CEGE 3102, and Phys 1301. As the semester progresses, we will use geometry, calculus, probability and statistics, and kinematics. Some of the homeworks and lab assignments will require spreadsheet work or programming in Matlabs. This class will not make use of extensive technical knowledge from any of the prerequisite courses. For instance, you will encounter basic calculus-based kinematic motion equations, but not momentum or energy problems. Rather, the challenge is in learning which techniques apply to which problems. **Success in CEGE 3201 relies on understanding the underlying core concepts and not just the calculations involved.** If it has been a while since you took these courses, you may find it worthwhile to review the prerequisites before the semester gets too busy.

[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.*

These co-requisites may be waived or satisfied by equivalent classes from other departments.

3.2 Course materials

The textbook for this course is *Principles of highway engineering and traffic analysis*, 7th edition, by Fred Mannering, Walter Kilareski, and Scott Washburn. Readings will be assigned at the end of each lecture to supplement material covered in class. The textbook also contains lookup tables for certain calculations, which we will reference in-class and on assignments. The cheapest new version I have seen is on the Wiley website. Older editions are probably usable, but you should find other ways to obtain the most recent versions of lookup tables and behavioral parameters for engineering problems.

Unfortunately, no recent textbook on transportation engineering covers all of the class material. Slides will be posted on the course website before each class. Slides contain links to solutions to in-class problems. At the end of each set of slides are reading assignments and suggested practice problems. For supplementary reading that covers certain topics in greater depth, I also recommend https://en.wikibooks.org/wiki/Fundamentals_of_Transportation, available online for free.

4 Assessment

Grades will be determined entirely by performance on homework and lab assignments.

Category	Weight
Homework assignments	30%
Lab assignments	30%
Midterm exam	15%
Final exam	25%

The +/− grading system will be used. At the end of the course, I may apply a curve if needed to ensure a proper grade distribution. Please feel free to contact me at any time during the semester to discuss your progress to date.

Assignments will be posted on Canvas and announced in class. Schedule changes will be announced on Canvas. Late submissions will be penalized by 30% (maximum score 70%), and will only be accepted up to one week late so that I can post solutions online. **Do not look at solutions from past semesters. I consider this academic dishonesty.** Some assignments will use similar solution methods as past problems, and reviewing past solutions will deny you the opportunity to discover the solution yourself.

Although attendance is not a component of the final grade, succeeding in this course requires full understanding of the concepts, and few students can achieve this without regular class attendance and participation. The class format (problem-based learning) is designed to encourage you to study and master the concepts during class.

4.1 Homework assignments

Homeworks will be assigned weekly and include both conceptual and engineering problem-solving questions. Homeworks will be challenging, and they will require significant time and effort. Do not wait until the night before to start! Understanding the engineering equations will not be sufficient to succeed on the homeworks; you must master the concepts to answer correctly. Homeworks will usually be assigned weekly and include conceptual or computational problems. You are encouraged to work together on homeworks, but **you must write your solutions individually, in your own words**. You may use spreadsheets or other computer software on the homeworks. Email your spreadsheets and programs to me as part of the homework submission.

4.2 Lab assignments

You will be assigned additional computer-based problems as lab assignments. These problems will focus on realistic datasets that are unwieldy to work with by hand. Therefore, we will be using Excel and Matlab to solve transportation problems with these datasets (hence the need for CEGE 3101 as a prerequisite). The TA session willintroduce the data and computer skills needed to complete these assignments, such as software used in practice (Synchro) or large datasets (trip surveys).

4.3 Exams

The midterm exam will be given around halfway through the semester during class time. The final exam is cumulative, and will be held at the University-scheduled time. Due to the COVID-19 restrictions, exams will be given online. Please have a scientific or graphing calculator available. You may use any notes or textbooks you have on the exam. However, you may not receive or give help to anyone else (including current and former students).

If you have a schedule conflict with an exam, please inform me as far in advance as possible so that alternative arrangements can be made. Depending on the circumstances, these arrangements may include taking a different exam before or after the scheduled time, additional assignments, and/or adjusting a student's final grade distribution. Except for unforeseen and documented emergencies, makeup exams will not be given without prior notice.

4.4 ABET student outcomes

This class addresses the following ABET student outcomes:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

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

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

4.5 Student learning outcomes

CEGE 3201 addresses two student learning outcomes. Both outcomes will be assessed through homeworks, lab assignments, and exams.

- Problem solving. Students will learn how to solve engineering problems; engineering methods will be discussed in class, but novel problems will be introduced in homework assignments that require students to adapt their knowledge of engineering methods to new types of problems.
- Critical thinking. Transportation systems are adapting to the emergence of automated vehicle technology. Students will study how existing engineering methods might be modified to more accurately model automated vehicles. Homeworks will include conceptual problems asking students to modify methods from class.

5 Miscellania

The University of Minnesota provides, upon request, appropriate academic adjustments for qualified students with disabilities. For more information, contact the Disability Resource Center at `https://diversity.umn.edu/disability/`. Mental health and stress management services are also available from UMN.

Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including failing the course and/or dismissal from the University. Since dishonesty harms the individual as well as other students, policies on scholastic dishonesty will be strictly enforced. At a minimum, students will receive a '0' for any plagiarized assignment.

Students may withdraw from a class within the first 2 weeks of class without penalty. Between 2 weeks and 10 weeks, students may 'W' drop a course without seeking approval. After 10 weeks, withdrawing requires an academic policy petition.

Please also refer to the following policy statements:

- Makeup Work for Legitimate Absences: Twin Cities, Crookston, Morris, Rochester
- Teaching and Learning: Student Responsibilities (Twin Cities, Crookston, Morris, Rochester)
- Sexual Harassment, Sexual Assault, Stalking and Relationship Violence
- Equity, Diversity, Equal Employment Opportunity, and Affirmative Action
- Academic Freedom and Responsibility

6 Schedule

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

Tuesday		Thursday	
1/18 Orientation	**1**	1/20 Trip generation	**2**
1/25 Mode choice	**3**	1/27 Shortest path	**4**
2/1 Trip distribution	**5**	2/3 Traffic assignment	**6**
2/8 Traffic assignment	**7**	2/10 Traffic assignment	**8**
2/15 Traffic assignment	**9**	2/17 Public transit	**10**
2/22 Public transit	**11**	2/24 Driver behavior	**12**
3/1 Traffic flow theory	**13**	3/3 **Midterm exam**	**14**
3/8 *Spring break*		3/10 *Spring break*	
3/15 Traffic flow theory	**15**	3/17 Traffic flow theory	**16**
3/22 Queuing theory	**17**	3/24 Queueing theory	**18**
3/29 Capacity / Level of service	**19**	3/31 Traffic signals	**20**
4/5 Traffic signals	**21**	4/7 Traffic signals	**22**
4/12 Traffic signals	**23**	4/14 Vertical geometric design	**24**
4/19 Vertical geometric design	**25**	4/21 Vertical geometric design	**26**
4/26 Lateral geometric design	**27**	4/28 Lateral geometric design	**28**