CEE 371: Introduction to Transportation Planning and Analysis

Instructor: Amanda Stathopoulos; Department of Civil and Environmental Engineering

- **Credits**: 1 Unit credit; Two lectures/week plus alternating Friday lab activities
- **Instructor**: Amanda Stathopoulos, PhD
- **Instructor email:** a-stathopoulos@northwestern.edu
- **TA**: Gretchen Bella
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- **Schedule**: Monday, Wednesday 2pm-4pm, selected Fridays 2-4pm
- **Textbook**: Readings are assigned on Canvas
- **Class Locations**
    - Mon+Wed classes in University Hall 121. 1897 Sheridan Road.
    - Friday classes in Tech institute M177 or select classrooms (see Canvas)
    - Exams: Transportation Center, 600 Foster.
- **Office hours**: 12.30-1.30pm Wednesdays in the instructor's Office: Tech A312. please email for other meeting times
- **Prerequisites**: No formal prereq.
- **Course audience**: CEE371 is an elective part of the CEE Major Requirements: Civil Engineering Breadth. CEE479 is a required part of the core classes for the graduate degree (MS or Ph.D.) in Transportation Systems Analysis and Planning. It is an elective for the Transportation and Logistics minor students and other interested students.
- **Canvas page**: tbd
- **Study guide –** updated links to reading and preparation material

Course description

In this course we will study the characteristics, functions, organization, operations, and planning of passenger and freight transportation systems, both urban and intercity facilities and services. We will discuss some history and explore contemporary and emerging transportation issues from the perspective of planning and analysis methods and considering sustainability, equity, and resilience. We will learn some useful tools for analysis, problem solving and service design, including elements of travel forecasting, network analysis, data analysis and sources, and transportation service design. We will devote some time to examining how transportation has been and can be used to allocate benefits – and negative impacts – across different places and demographic groups. My objective is for you to gain a strong sense of the systems, processes, benefits and costs of transportation, the professional challenges in the field, as well as to ignite your curiosity to learn more. Transportation analysis is a highly interdisciplinary effort, and we will investigate how land-use, law, history, behavior, economics, urban design, and other disciplines intersect with our work in this class.

We will find that transportation is more than cars on a freeway or people riding a CTA bus. It facilitates life as we know it, defines where – and how – people live, work, and shop, supporting a diverse and dispersed economy, consuming vast amounts of money, time, energy, and environmental resources in the process.

Instructors

I have been at Northwestern since 2014 and have been teaching a module in CEE371/479 for eight years. I am excited to take over the whole class in 2023 after the retirement of Prof.

Schofer who taught different iterations of this course for 40 years. My research is in the area of travel demand, new forms of mobility, and modeling of decisions and I hope to guide you through the complexity and multidisciplinarity of transportation analysis and planning in this class and awaken your curiosity in the role that transportation plays in meeting a range of community and governance goals. With this goal in mind, I designed this class to balance between learning *methods and tools* for transportation planning on the one hand, to also learn the *soft skills* of contextualizing, critiquing and communicating that is essential for informed and effective planning.

We are very fortunate to have **Gretchen Bella**, a doctoral student in the transportation systems program, as our Teaching Assistant for the second year of this class. Gretchen has experience with engineering practice as well as a degree from UT Austin in transportation engineering. You will find her to be knowledgeable, supportive, and passionate about researching various transportation problems related to equity, health, and big data.

Operations.

We meet for lectures and class activities on Mondays and Wednesday from 2:00 until 3:50. The class will also meet on 5 Fridays for lab activities (week 3,5,7,9,11). The Friday meetings take place in Tech M177, from 2:00 until 3:50. These sessions are dedicated to regression lab, team-meetings, discussion sessions and presentations of projects.

Office hours generally take place on Wednesdays 12.30-1.30pm in my office, Tech A312. Additional check-ins are scheduled to keep teams on track when working on the memo and presentation preparation. These times will be announced in the canvas schedule.

Interaction and engagement.

This class will be interactive – during lectures I expect you to answer questions and to ask yours, to bring ideas and examples, and to explore and share issues on your own. We will learn together through lectures, in-class problem-solving, discussions, quizzes, individual and team-based homeworks, as well as lab activities.

Preparation/textbook.

The class has no single textbook but relies on various articles, reports, videos, podcasts, and visuals to support learning. The **Canvas study guide** gives a detailed listing of preparation, class activities and materials covered for each lecture. Class meetings will focus on shorter instruction activities along with application, critical thinking, or interactive discussions around the class topics. Therefore, students need to stay up to date with their reading/preparation and go over announced material in advance to get the most out of classes. To promote reflection, learning and connecting theory and practice we will have recurring short in-class and out-of-class (canvas) writing exercises. This is a new teaching tool we are testing out this year.

Course goals and learning objectives.

This course is informed by the idea that effective urban interventions require knowledge about the core issues, their analytical representations as well as the surrounding environment in terms of governance and technological developments. The overall **course goal** is to prepare students to think through planning and analysis of transportation systems in an era of rapid change. Pressures and aspirations for planning outcomes are changing, technology and attitudes are evolving, and there are several different stakeholders and experiences to account for. This calls for future engineers, planners, and transportation practitioners to know tools and methods, as well as the broader context of planning.

The key **learning goals of this class are:**

1. Students will demonstrate **knowledge** of the basic theories and facts of transportation planning. This includes an ability to analyze the transportation planning process and stakeholders, assess competing goals and methods of transportation planning, understand the past, present and future of planning for different modes, geographies, and community needs. This goal is consistent with ABET Program outcome number 7.
2. Identify and describe suitable **engineering solutions** to transportation planning and analysis challenges. This includes interpreting and using travel demand results, interpreting shortest path algorithms, design of complete streets, or analyzing household travel data to inform policymaking. This goal is consistent with ABET Program outcome number 6.
3. Clearly **communicate** information in written and oral formats. Students will show ability to produce presentations, engineering memos and other written material that balance technical and practical content suitable to different audiences. This goal is consistent with ABET Program outcome number 3.
4. Skills in **teamwork**. Students will show the ability to work effectively in teams. For CEE371 this is centered on demonstrating: a) participation in group decision-making and coordination, b) prioritizing team project plans, schedules, and equitable management of people, c) coordinated joint deliverable of reports and oral presentations. This goal is consistent with ABET Program outcome number 5.
5. Develop **critical thinking skills for transportation**. In this course this is centered on: a) consideration of different perspectives, stakeholders, and trade-offs; b) consideration of the problem/technology implementation context; c) ability to incorporate both qualitative and quantitative aspects in your work, and; d) understanding the limitations technological solutions and avoid pitfalls/unintended consequences.
6. Foster creativity and curiosity about investigations surrounding transportation problems and solutions, and connect knowledge to their own area of engineering/science expertise.

Table 2. Goals and assessment overview

Course goals	ABET outcomes	Criteria met via	Performance indicator	Assessment	Proposed Action
1 - **Knowledge**	7	Midterm Written Exam, Final Written exam, Homeworks * 3	Result on entire Exams and Homework	tbd	tbd
2: **Apply engineering analysis**	6	Midterm Written Exam, Final Written exam, Homeworks * 3, Team field-work project 1&2	Result on entire Exams and Homework	tbd	tbd
3: **Communication**	3	In-class discussions, Team field-work project 1&2, Midterm Written Exam,	In-class engagement, Result on entire Exams and Homework,	tbd	tbd

		Final Written exam, Homeworks * 3	delivery of Team field-work memo and presentation		
4: **Teamwork**	5	Team field-work project (2 deliverables)	Delivery of team report and oral presentations	tbd	tbd
5: **Critical thinking**	2	In-class discussions, Midterm Written Exam, Final Written exam,	Select questions in Exams and in-class discussion	tbd	tbd
6: **Creativity and curiosity**	na	In-class discussions, Team field-work project			

Student assessment

The examination is based on a diverse set of activities designed to foster an understanding of current theories, issues, and empirical cases of transportation planning, and allow students to apply and evaluate different formal methods to analyze policy and planning innovations.

- Three **take-home assignments** will involve practical hands-on transportation system analysis tasks coupled with interpretation reflection. Students will have 1-2 weeks to deliver homework on canvas. Students can upload a typed or handwritten document containing analysis results along with relevant writing/drawings/calculations in response to the homework question.
- Two **written exams**, a midterm and final will be done in person using pen and paper. No computers are allowed but students can bring hand-written notes to the exam.
- The **team-based project** is designed as a field-based intersection observation applying real-world transportation analysis tools, followed by a proposed re-design. Students will deliver two memos coupled with in-class presentation and discussion. A representative from the city of Evanston as well as other practitioners will attend the design presentation.
- For **attendance, the grade** requirement is described under 'Attendance policy' below.
- All dates and deadlines will be posted on canvas in advance.

Table 3. Assessment and grading overview

Task	Description of graded activities	Share of the final grade	Graded as
Participation & Engagement in classroom discussion	Both attendance and various forms of class engagement will count (in and out of classroom quizzes, team-discussions, reflections, summaries)	**18%** [8 for attending; 10 for active engagement]	Letter-grade
Mid-term written exam	A written in person exam. No computers allowed. Students can bring 4 sheets of handwritten notes. Calculator TBD.	**18%**	Letter-grade
Final written exam	A written in person exam. No computers allowed. Students can bring 8 sheets of handwritten notes. Calculator TBD.	**22%**	Letter-grade
3 take-home assignments	3 written take-home assignments will be administered. See schedule in study guide	**18%** [6 per assignment]	Letter-grade
Team project: real world observation and presentation	2 team-based deliverables on a formal analysis and proposed design for Evanston intersection (half grade associated with memo, half grade associated with the oral presentation)	**22%** [10 for memo+present 1; 12 for memo 2 present]	Letter-grade

The grading will align with the following expectations for performance.

Table 4. Grading expectations

Lettergrade	Points	Percent	Expected performance
A	4	94-100%	Mastery: Sophisticated understanding of material and methods
A–	3.7	90-94%	Excellent performance
B+	3.3	87-90%	Very Good
B	3	84-87%	Solid but some room for improvement
B–	2.7	80-84%	Consistent issues
C+	2.3	77-80%	
C	2	74-77%	Significant weakness
C–	1.7	70-74%	
D	1	60-70%	Passing, but many failed tasks
F	0		No Pass grade

Attendance/participation policy

Attendance and engagement in the class sessions is essential since that is where we do active learning, discussion, reflection, and work through examples and case studies. The participation grade is made up of attending class (8%), and participating actively (10%).

Attendance: If you are unable to attend a lecture, please let me know as soon as possible by sending me an email (a-stathopoulos@northwestern.edu) titled 'CEE371 Absence'. For

ordinary classes I ask that any missed class is made up by writing a 500 word summary with 3 learning takeaways of the class content, and send it by Friday midnight of that week. This will give 80% credit for that missed class. More than 2 missed classes require that you contact me for a meeting to discuss further so that I can make sure you stay on track. If you are missing several classes due to persistent health or other issues, please contact me for support and instructions for alternative assessment modes. Please do not come to class if you are experiencing symptoms of illness.

For any missed class you can catch up on readings and lecture material by talking to classmates and checking Canvas. Recordings of most lectures will be available.

Engagement/Active participation: This year we introduce short reflection and critical thinking tasks both within classes and out-of-class as homework each week. Completing these mini-homework assignments is essential to cover the 'participation' part of the attendance grade. We hope that these short activities help reinforce course preparation and reflections.

Late policy and grace days for take-home assignments and homework

The date and cutoff time for all take-home assignments and mini-homework assignments listed in table 3 are posted on Canvas (most assignments are due at midnight but some are due ahead of class time). Any late submissions will be assigned a penalty of 10% of the grade per day late.

You are granted **one** 'no explanation needed' **grace day** only applicable for the **take-home assignments**. This means you can give yourself an extra day without any penalty. I recognize that even careful plans can sometimes be derailed by illness, computer problems, theft, or personal situations. Students get to decide when to use the grace day, and you do not need to explain or notify me. Instructor-granted extensions will only be considered for exceptional circumstances and students need to be diligent about communicating this as soon as possible.

Course Details Subject to Change

Please note that the specifics of a course syllabus are subject to change in the case of unforeseen circumstances. Instructors will notify students of any changes as soon as possible. Students will be responsible for abiding by the changes.

Use of generative AI

This course is "Conditional" or "Open" to the use of Generative Artificial Intelligence (GAI) for each of the assignments. Please view specific instructions for each assignment regarding the use of GAI. In some cases, it will be open to using GAI, but I will ask you to be transparent and reflect on the experience as part of writing memos and take-home exams. Instead for written exams, in-class engagement, and homework it will be used conditionally, for preparation and synthesis but not for the assignment itself. GAI can make for a fantastic tool to help you build knowledge and speed up workflows, but there are also challenges.

Copilot is the University's supported artificial intelligence service. When using Copilot while actively logged in with a Northwestern account, data is stored securely in Northwestern's Microsoft tenant, and Microsoft will not use it for product improvement or to train its AI models.

Some key things to keep in mind as you use GAI:

- **Data privacy**: the data you share as part of your queries in generative AI tools such as Bard/Gemini, ChatGPT, will be accessible by others using the same tools. This is because generative AI learns by collecting, analyzing, and storing user-provided information. Therefore, University faculty, staff, students, and affiliates should not enter institutional data into any generative AI tools that have not been validated by the University for appropriate use and have explicit permission of the data provider.

- **Accuracy issues**: GAI models are trained on copious existing data but can be biased or inaccurate, especially if queries are not well written. GAI can also hallucinate information that is untrue, hence you need to verify it's products.
- **Timeliness**: GAI has a cutoff for it's learning, and does poorly for new phenomena and trends.

Class topics outline

Below is the tentative schedule for the quarter. It will almost certainly change, mostly through shifts in the schedule of topics. Deliverable dates are due dates. Please use Canvas as the main guide for topics, deadlines and preparation for class.

Table 5. Outline of class topics

	Monday (University Hall)	Wednesday (University Hall)	Friday (M177)
Week 1	**23rd Sep** No class	**25th Sep** Class overview; Introductions; Transportation planning fundamentals; All-class exploration of contemporary transportation issues and problems.	* start of team project - Team Matching Survey due
Week 2	**30th Sep** Transportation **planning fundamentals**; brief history of transportation engineering and planning; Agencies and stakeholders; Federal mandates and motivations. Process steps. Moving people vs. moving cars?	**2nd Oct** All students @ Transportation library **45 min: Transportation data**: sources, uses, trends. ACS, NHTS, regional travel surveys, real-time tracking data, privacy issues, value of data **Walk to library together** **1 hr:** Intro to the Transportation Library; team meet and greet Office hours 12.30	**4th Oct** * HW1 assigned "gravity model"
Week 3	**7th Oct** All students Introduction to **travel forecasting** for transportation planning: prediction or planning? 4-step planning process; modeling & forecasting; planning goals; trip generation approaches and uncertainties; gravity model overview of mode choice; Overview of activity-based models. *HW2a due (ungraded)	**9th Oct** All students | Comp. Lab MG47 **Regression Overview - 1 hr** **Transportation data hands on lab - 1 hr**; linking demographics to travel choices; deriving trend to inform modeling and forecasting Office hours 12.30	**11th Oct** **Transportation data hands on lab drop-in review, as necessary**: optional TA office hours in the computer lab to go into more detail about modeling * HW1 due "gravity model" * HW2 assigned All teams check-in CEE small conf room * Informal check-in with teams (10 min)
Week 4	**14th Oct** All students **Behavioral models data & formulation**; Stated and revealed data-collection; introducing the logit demand model, rational agent and alternative frameworks; Competing mental models. Complexity vs realism.	**16th Oct** All students Logit model **derivation and application**; random utility modeling; maximum likelihood estimation; Forecasting scenarios, elasticities & willingness to pay. Walk through a study	**18th Oct**

		Office hours 12.30	
Week 5	**21st Oct** All students | NUTC Ruan Transportation planning challenges. Transportation & Politics: road pricing, political and public acceptability * Team memo 1 due	**23rd Oct** All students | NUTC **Transit planning and design** Transit performance; Federal guidance on performance-based planning; mobility vs. accessibility; Meaning and definitions of equity for transportation: allocation of costs and benefits; Transit – technologies, roles, and utilization, competitiveness with auto; essential workers and no-choice riders **Fare Free Transit Discussion** Office hours 12.30	**25th Oct** ***In-person TA office hours in the classroom -*** last minute homework questions or assistance before Monday presentation * HW2 due "simple trip making model with real data"
Week 6	**28th Oct** All student Teams *Student team presentation on intersection observation Memo 1. 8 minutes presentation and Q&A (10 teams) traffic counts, accident analysis and 'existing state' reporting. Feedback and discussion	**30th Oct** All students The **freight** industry and supply chains – Amazon and beyond; e-commerce and structure of the industry; **city logistics policies** Office hours 12.30	**1st Nov**
Week 7	**4th Nov** All students | NUTC Ruan (tbd) *MIDTERM WRITTEN EXAM (in person, no computer, notes allowed)	**6th Nov** All students **Network representation and analysis**: minimum path finding and equilibrium assignment. Methods and assumptions. Data requirements, sources, and collection methods. Use in operations management. lecture by **Gretchen Bella** Office hours 12.30	**8th Nov M177** * start of Memo II work Friday Discussion **Modeling under Uncertainty**: The TMIP approach
Week 8	**11th Nov** All students **Stacy Meekins Guest Lecture: New planning concepts,** Defining complete streets; Complete Streets tools and terminology; complete streets planning and implementation. Project life-cycle; Case study examples; class break-out with design task	**13th Nov** All students **BAC Workshop** Office hours 12.30	**15th Nov** *Throughout week: claim a meeting spot for team check-ins with professor or TA outside of class time (whole team expected to attend)*
Week 9	**18th Nov** All students | **Resilience and disruptions;** Measuring and designing for transportation resilience; Restorations vs prevention; Focus on Natural hazards, climate change, demographic change and human-made hazards; Federal guidance on vulnerability assessment and resilience; Resilience metrics and indicators; Resilience in practice→preparing and reacting. Assess criticality and centrality in network; Why resilience implementation is so challenging * HW3 due: network model	**20th Nov** All students **Prof. Schofer Guest lecture:** Traffic safety, infrastructure, disaster events and planning for the future Office hours 12.30	**22nd Nov** | NUTC Ruan **Student presentation of design ideas (8 team presentation). Feedback and discussion**
Week 10	**25th Nov** All students	**27th Nov**	

	New mobility: app-based & on-demand; Mobility as a Service: MAAS and smart cities; Automation & Sharing economy. Post-covid city; Equitable transportation in a changing city * Team memo 2 due	Thanksgiving vacation begins **No class**	
Week 11	**2nd Dec** All students Final lecture → Wrapping up of class; joint reflections	**4th Dec** All students Final Exam	**6th Dec All** students | NUTC Ruan *Final Written exam alt date
Week 12 exam week	**December 4th** No activities		

Accessibility

Northwestern University is committed to providing the most accessible learning environment possible for students with disabilities. If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the quarter, so we can work together to implement your accommodations. Should you anticipate or experience disability-related barriers in the academic setting, please contact AccessibleNU to move forward with the university's established accommodation process (e: accessiblenu@northwestern.edu; ph: 847-467-5530). Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

Support for Wellness and Mental Health

I am committed to supporting the wellness of NU students. Student Affairs has multiple resources to support student wellness and mental health. If you are feeling distressed or overwhelmed, please let me know, and reach out for help. Students can access confidential resources through the Counseling and Psychological Services (CAPS), Religious and Spiritual Life (RSL), and the Center for Awareness, Response, and Education (CARE). Additional information on all of the resources mentioned above can be found here:
https://www.northwestern.edu/counseling/
https://www.northwestern.edu/religious-life/
https://www.northwestern.edu/care/

Acknowledgement.

A prior version of this class was taught by Professor Joseph Schofer for several decades. The current course design is inspired by the structure he used for teaching, and I have benefitted from guidance and material to use for my teaching of the class editions in 2023 and 2024. There has bene many innovations to the course structure, including a team-work with field observation, hands-on data-analysis activities, and new topics and discussion themes. In 2023/2024 the course was updated to focus on complete streets with a guest lecture by Stacey Meekins from Sam Schwartz, a guest lecture by Dr Schofer on transportation safety, a Transportation Library session with Rachel Cole, and a design jury visit by Lara Biggs from the City of Evanston.