Transportation Engineering Applications
CIVE 341 Winter 2021

University of Waterloo
Department of Civil and Environmental Engineering

Calendar Entry: Traffic engineering and travel forecasting. Evaluation, design and management of urban transport systems through advanced traffic control techniques. Quantitative methods for evaluating investments in transportation infrastructure or operational changes.

Instructor:

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Teaching Assistants:

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Course Organization:
Lectures and Tutorials:
Pre-recorded videos (asynchronous), posted weekly on LEARN

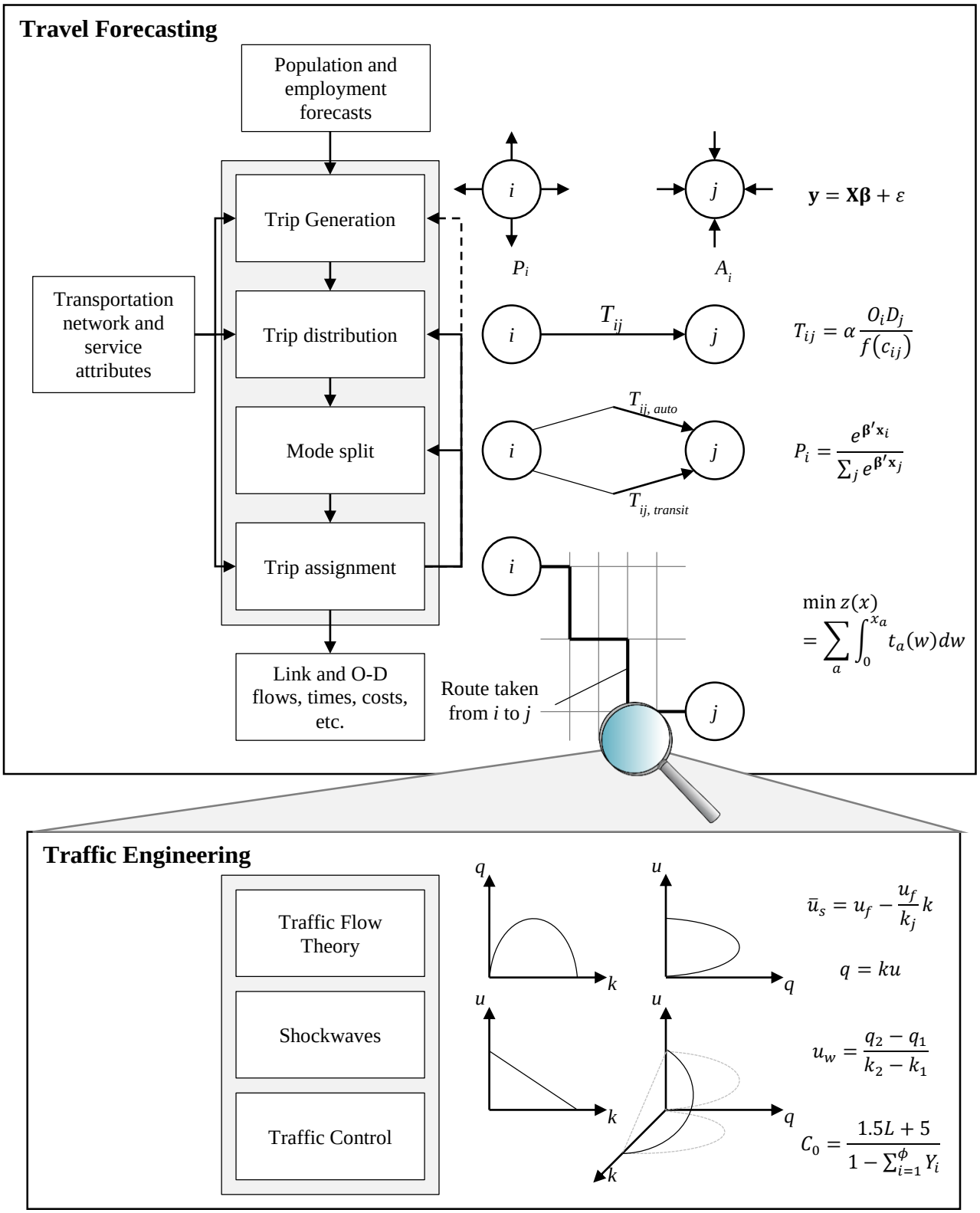
Office Hours:
Live (synchronous)

TAs:	Thursdays, 12:00 – 1:00 PM ET, Webex link via LEARN
Instructor:	Tuesdays, 12:00 – 1:00 PM ET, Webex link via LEARN

Course Learning Outcomes:
At the end of the course students should be able to:

1. Define macroscopic traffic flow elements (flow, density, speed), discuss their fundamental relationships, and implement a complete macroscopic traffic flow model.
2. Implement quantitative analyses of all shockwave types resulting from traffic disruptions (e.g., signalized intersections, along a highway, bottlenecks and accidents).
3. Define microscopic traffic flow elements (position, speed, acceleration), discuss their interactions, and implement a complete microscopic car-following model.
4. Design and evaluate traffic control techniques for signalized intersections.
5. Calibrate, validate, and apply trip generation, trip distribution, mode split, and trip assignment models, using appropriate procedures, measures, and techniques.
6. Evaluate the impacts of changes in population, employment or transportation network and service attributes, on link and path flows and travel times.
7. Discuss relevant underlying modelling assumptions and limitations, as well as their influence on model results.

Course Concept Map:



Course Topics:

Date (tentative)	Topic	Recommended Reading
Week 1	**Introduction**	Wellington
Week 2	**Macroscopic Traffic Flow Theory** • Basic traffic variables • Fundamental diagrams (Greenshields and Greenberg) • Model calibration using linear regression • Complete macroscopic traffic flow model	Garber & Hoel
Week 3	**Microscopic Traffic Flow Models (Intro)** • General motors model • The Wiedemann 99 Model	Garber & Hoel
Week 4	**Shockwave Analysis** • Signalized intersections • Along a highway • Bottlenecks (and accidents)	May
Week 5	**Traffic Control** • Pre-timed (Webster) and actuated signal design • Traffic signal coordination • Some common progressions (time permitting)	Garber & Hoel
-	**Reading Week**	
Week 6	**Trip Assignment I** • Transportation Demand, Supply, and Equilibrium • User equilibrium • System optimal	Sheffi
Week 7	**Trip Assignment II** • Network Models • Formulating the assignment problem as a mathematical program • Braess's paradox	Sheffi
Week 8	**Trip Generation** • Regression models • Cross classification models	Ortuzar & Willumsen
Week 9	**Trip Distribution** • Gravity models • Growth factor models	Ortuzar & Willumsen
Week 10	**Mode Choice I** • Introduction to Utility Theory • Derivation and Application of Logit Models • Maximum Likelihood Estimation (Disaggregate data)	Train
Week 11	**Mode Choice II** • Ordinary Least Squares (OLS) Estimation (Aggregate data) • Limitations of Logit • Nested Logit Application and Estimation	Train

Reference Texts (see excerpts posted on LEARN):

1. Wellington, Arthur Mellan. (1887). Introduction. In *The economic theory of the location of railways* (pp. 1-9). New York: John Wiley and Sons.
2. Garber, N. J., & Hoel, L. A. (1999). *Traffic and Highway Engineering* (2nd ed.). Toronto: PWS Publishing.
3. May, A. D. (1990). *Traffic Flow Fundamentals*. Englewood Cliffs, NJ: Prentice Hall.
4. Sheffi, Y. (1985). *Urban transportation networks: Equilibrium analysis with mathematical programming methods.* Englewood Cliffs, NJ: Prentice-Hall, Inc. http://sheffi.mit.edu/urban-transportation.
5. Ortuzar, J. D., & Willumsen, L. G. (2011). *Modelling transport* (4th ed.). West Sussex, England: John Wiley & Sons, Ltd.
6. Train, K. E. (2009). *Discrete choice methods with simulation* (2nd ed.). New York, NY: Cambridge University Press. https://eml.berkeley.edu/books/choice2.html.

Course Website: https://learn.uwaterloo.ca

Evaluation:

Assignments		30%
1. Traffic Flow Theory	6%	
2. Shockwaves & Traffic Control	6%	
3. Trip Assignment	6%	
4. Trip Generation & Distribution	6%	
5. Mode Choice	6%	
Mid-Term		35%
Final Exam		35%

Late Work:
Assignments are due by the date and time specified on the assignment. Only an electronic version, in **PDF format**, should be submitted to the corresponding LEARN drop box. Please check your file once uploaded to ensure all pages were uploaded correctly. No further files will be accepted after the submission deadline. **Late assignments will receive a grade of zero**. Exceptions will only be made under **unforeseeable and extraordinary circumstances**.

Other Course Policies:

Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check the Office of Academic Integrity for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. [Check the Office of Academic Integrity for more information.] A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the Undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties, check Guidelines for the Assessment of Penalties.

Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals.

Note for students with disabilities: AccessAbility Services, located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

The Writing Centre: The Writing Centre works across all faculties to help students clarify their ideas, develop their voices, and write in the style appropriate to their disciplines. Writing Centre staff offer one-on-one support in planning assignments and presentations, using and documenting research, organizing and structuring papers, and revising for clarity and coherence. You can make multiple appointments throughout the term, or drop in at the Library for quick questions or feedback. To book a 50-minute appointment and to see drop-in hours, visit www.uwaterloo.ca/writing-centre. Group appointments for team-based projects, presentations, and papers are also available.

Please note that writing specialists guide you to see your work as readers would. They can teach you revising skills and strategies, but will not proof-read or edit for you. Please bring hard copies of your assignment instructions and any notes or drafts to your appointment.