CEE_ENV 471-II: Transportation Systems Analysis II
Spring 2021

Course:

Lecture:	Monday/Wednesday 2:00 - 3:50 pm on Zoom (see Canvas for Zoom link)
Instructor:	Marco Nie
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Office Hours:	Monday/Wednesday 1:00–1:50 pm, and by appointment

Description: As a sequel to CEE_ENV 471-I, this course extends transportation systems analysis to accommodate *dynamics in travel demand and network flow* and *operation and design of urban transit systems*. The primary objective is to introduce the students to the fundamental principles and mathematical methods that guide these active areas of transportation research and practice. Students will be exposed to both the classic work and the latest developments in the filed, and be encouraged to ask and address research questions of their own. The course has three pillars. The first is the simple and powerful economic model of morning commute problem, which endogenizes both departure time choice and traffic dynamics. The more general optimization approach that is built under the umbrella of dynamic traffic assignment (DTA) will also be reviewed and compared with the morning commute model. The main components of the DTA approach, including basic traffic flow models, time-depending shortest path problems, and assignment models, constitute the second pillar of the course. The third pillar of the course is principles for operating and designing urban transit systems.

After taking this course, students should be able to (1) use typical traffic flow models (e.g. bottleneck models, kinematic wave model) in transportation system analysis; (2) solve morning commute problems under simple settings and make economic/policy interpretation of the solutions; (3) solve time-dependent and adaptive shortest path problems; (4) classify and analyze various system optimal and user equilibrium DTA formulations; (5) create simple timetables according to observed transit load profiles; (7) perform sketch design of simple transit systems; and (8) understand basic transit route choice and frequency-based transit assignment models.

Prerequisites: Students are recommended to take CEE_ENV 471-1 before taking this course. This may not be considered a prerequisite for students with a solid background in optimization. Students should be able to write simple computer programs in MATLAB or any equivalent or lower-level languages (such as Java, C++, FORTRAN, C etc.)

Recommended Text:
No textbook required.

References:

Bin Ran and David Boyce (1996) Modeling Dynamic Transportation Networks, Springer.

Sheffi, Y. (1985). Urban Transportation Networks. Prentice-Hall, NJ.

Avishai Cedear (2008). Public Transit Planing and Operation. Elsevier.

Vuckan R. Vuchic (2007) Urban Transit: Systems and Technology. John Wiley & Sons, Inc.

Suggested readings:

Morning commute

Vickrey, W. (1969). ”Congestion theory and transport investment.” American Economic Review 59, 251-261. 3.)

Henderson, J. V. Road congestion: a reconsideration of pricing theory, Journal of Urban Economics, 1974, 1, 346-355.

Hendrickson, C. & Kocur, G. Schedule Delay and Departure Time Decisions in a Deterministic Model Transportation Science, 1981, 15, 62-77.

Smith, M. J. The Existence of a time-dependent equilibrium distribution of arrivals at a single bottleneck Transportation science, 1984, 18, 385-394.

Daganzo, C. F. The uniqueness of a time-dependent equilibrium distribution of arrivals at a single bottleneck Transportation science, 1985, 19, 29-37.

Mahmassani, H. and R. Herman. (1984). ”Dynamic User Equilibrium Departure Time and Route Choice on Idealized Traffic Arterials.” Transportation Science 18, 362-384. 4.

Arnott, R., De Palma, A., Lindsey, R., et al., 1990. Economics of a bottleneck. Journal of Urban Economics 27, 111-130.

Arnott, R., De Palma, A., and Lindsey, R. (1993). A structural model of peak-period congestion: A traffic bottleneck with elastic demand. The American Economic Review, 161-179.

Arnott, R., A. de Palma and R. Lindsey. (1990). ”Departure Time and Route Choice for Routes in Parallel.” Transportation Research 24B, 209-228. (Recommended for “Morning commute”)

Dynamic network loading and traffic assignment

Merchant, D.K., Nemhauser, G.L., 1978a. A model and an algorithm for the dynamic traffic assignment problem. Transportation Science 12, 183-199.

Merchant, D.K., Nemhauser, G.L., 1978b. Optimality conditions for a dynamic traffic assignment model. Transportation Science 12, 200-207.

Friesz, T. L., D. Bernstein, T. E. Smith, R. L. Tobin and B. W. Wei. (1993). "A Variational Inequality Formulation of the Dynamic Network Equilibrium Problem." Operation Research 41, 179-191.

Mahmassani, Hani S., and R. Jayakrishnan, 1991. "System performance and user response under real-time information in a congested traffic corridor." Transportation Research Part A: General 25, 293-307.

Daganzo, C. F. (1994) "The Cell Transmission Model: a Dynamic Representation of Highway Traffic Consistent with the Hydrodynamic Theory". Transportation Research 28B, 269-287.

Daganzo, C. F. (1995). "The Cell Transmission Model, Part II: Network Traffic." Transportation Research 29B, 79-93.

Nie, Y., Jingtao Ma and H. M. Zhang (2008) A polymorphic dynamic network loading model. Computer- Aided Civil and Infrastructure Engineering, 23, pp. 86 - 103.

A. K. Ziliaskopoulos and H. Mahmassani. Time-dependent, shortest path algorithms for real-time intelligent vehicle highway system applications. Transportation Research Record, 1408:94 - 100, 1993.

I. Chabini. Discrete dynamic shortest path problems in transportation applications. Transportation Research Record, 1645:170-175, 1998.

Transit and ride-hail

Marguier, P. H. J., A. Ceder. 1984. Passenger waiting strategies for overlapping bus routes. Transportation Sci. 18(3) 207-230.

Spiess, H., M. Florian. 1989. Optimal strategies: A new assignment model for transit networks. Transportation Research Part B 23(2) 83-102.

Gentile, Guido, Sang Nguyen, and Stefano Pallottino. "Route choice on transit networks with online information at stops." Transportation science 39.3 (2005): 289-297.

Daganzo, C. F. (2010). Public Transportation Systems: Basic Principles of System Design, Operations Planning and Real-Time Control. Lecture notes, University of California, Berkeley.

Daganzo, Carlos F. Structure of competitive transit networks. Transportation Research Part B:

Methodological 44.4 (2010): 434-446.

Douglas, G. W. (1972), Price regulation and optimal service standards: The taxicab industry', Journal of Transport Economics and Policy, 116–127.

Arnott, R. (1996), Taxi travel should be subsidized. Journal of Urban Economics 40(3), 316– 333.

Homework and projects: There will be three homework assignments, a discussion assignment and one course project. Some assignments may involve writing simple computer codes to solve problems studied in the class. For the course project, you will be asked to write a short 5-page research proposal to National Science Foundation (NSF), showcasing one of your brilliant ideas that you believe is worthwhile to be funded. Other than you should make the proposed research a relevant application of what you have learned from the class, there is no other restriction on the subject. Students will make a final presentation on the topic of the course project.

Exams: No exams will be given.

Grading: The final grade will be assigned on the following basis:

Homework	45%
Paper discussion	20%
Proposal	35%

Working Together: Working together on homework is accepted. However, students are expected to write up their own versions of solutions. Depending on the class size, students may be asked to form teams to do the course project. A team may not have more than two members who will submit a joint project report and receive the same grade. Working together on exams, of course, is forbidden.

Table 1: CIV_ENG 471-II Course Schedule (Spring 2021)

Date	Week	Topic	Assignment	Due
29-Mar	1-1			
31-Mar	1-2	Introduction		
5-Apr	2-1	Traffic flow theory		
7-Apr	2-2	Traffic flow theory	Proposal	
12-Apr	3-1	Morning commute problem		
14-Apr	3-2	Morning commute problem	Homework 1	Discussion 1
19-Apr	4-1	Morning commute problem		
21-Apr	4-2	Dynamic network loading (DNL)		
26-Apr	5-1	DNL		Homework 1; Discussion 2
28-Apr	5-2	TDSP	Homeowork 2	
3-May	6-1	DTASO		
5-May	6-2	DTASO		
10-May	7-1	General DTA model: UE		Homework 2; Discussion 3
12-May	7-2	Transit capacity analysis		
17-May	8-1	Transit time table		
19-May	8-2	Transit route choice / assignment	Homework 3	
24-May	9-1	Transit design		Discussion 4
26-May	9-2	Transit design		Homework 3
31-May	10-1	Memorial day (no class)		Proposal
2-Jun	10-2	Transit design		Discussion 5.