



CE 521: Transportation Systems Analysis

Units: 4

Fall 2023— M W—1100-1240

Location: WPH 106

Instructor: Dr. Ketan Savla

Office: KAP 254A

Office Hours: Mondays, 1600-1800

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Course Description

This 4 unit course, geared towards Masters and PhD students, discusses economic and system level aspects in general that are central to transportation systems, with emphasis on theoretical and analytical tools. Topics to be covered include economic theories of the firm, the consumer, and the market, demand models, discrete choice analysis, cost models, and pricing theory. The objective is to enable students to apply these concepts for congestion pricing, technological change, resource allocation, market structure and regulation, revenue forecasting, public and private transportation finance, and project evaluation. It is the intention to present the material agnostic to any specific mode of transportation.

Learning Objectives

By the end of the course, the student will be able to:

- Formulate appropriate discrete choice model for a given decision scenario under uncertainty
- Exhibit familiarity with analytical and numerical approaches to market share prediction using discrete choice models
- Articulate important components of travel demand modeling and understand their interdependence
- Apply traffic flow theory to quantify congestion
- Apply dynamic traffic assignment to predict network performance under standard traveler behavior assumptions
- Quantify short run and long run costs of public transit
- Determine tolls for highways and bottlenecks using congestion pricing theory
- Design optimal layout for road and transit systems
- Determine optimal investment for highway capacity expansion
- Perform independent theoretical, numerical or data analysis research for class project

Prerequisite(s): None

Corequisite(s): None

Concurrent Enrollment: None

Recommended Preparation:

- Basic Optimization (e.g., ISE 330)
- Principles of Transportation Engineering (e.g., CE 471)

Course Notes

Lecture notes and other relevant class information will be posted on the blackboard website.

Technological Proficiency and Hardware/Software Required

Homework sets will include computational exercises, for which working knowledge of MATLAB, python or similar, would be beneficial.

Required Readings and Supplementary Materials

[1] E. Cascetta. *Transportation Systems Analysis*. Springer 2009. ISBN: 9781461424482

[2] Kenneth A. Small and Erik T. Verhoef. *The Economics of Urban Transportation*. Routledge, 2nd edition, 2007. ISBN: 9780415285155

Description and Assessment of Assignments

Homework will be generally released on blackboard every other week, and it will be due on blackboard before the start of the class two weeks later. The homeworks will consist of a combination of analytical, numerical and programming-based exercises. Moderate collaboration with classmates is encouraged. However, you will not be able to learn the material unless you invest enough time alone to understand each

homework problem, and independently write the solutions that you turn in. Late homework will not be accepted.

Grading Timeline

One week after submission.

Additional Policies

Attendance of the lectures is expected.

Grading Breakdown

Homework assignments	30 %
There will be a total of six homeworks	
Midterm exam	30 %
Class Project	40 %
5% preliminary proposal	
10% interim report	
10% project presentation	
15% final report	

Class Project

The purpose of the class project is to encourage students to apply the concepts and tools learned in the class to a case study of their choice. The students are expected to work individually on their projects.

Students will individually select a topic. Students are then expected to do literature review, perform theoretical, numerical or data analysis research, write a report and present their results to the class. The data needed for the projects will be collected from existing databases, repositories, or case studies, and will be identified with the help of the instructor. A good starting point for selecting a topic are the references from the textbooks used in the class. It is expected that the final output of the project will be suitable for a technical report. The project should show depth in at least one of four areas covered in the class, i.e., demand modeling, supply modeling, equilibrium analysis, and intervention (pricing, investment, etc.), and show adeptness at using at least one computational tool (optimization, regression, statistical analysis, etc.)

Project Timeline:

- Week 5: Project proposal due
- Week 9: Interim report due
- Week 15: Project presentation
- Finals week: Final report due

Project Proposal: One page document, minimum of 10 pt, single spaced, single column, containing:

1. project topic,
2. name of the student,
3. references to the material that the student plans to cover, and
4. short description of the goals of the project.

Interim report: A maximum of 5 page document, minimum of 10 pt, single spaced, single column, containing:

1. project topic,
2. name of the student,
3. review of literature,
4. preliminary results.

Final report: A maximum of 10 page document, minimum of 10 pt, single spaced, single column, containing:

1. project topic,
2. name of the student,
3. review of literature,
4. final results and conclusion.

In-class presentation: A total of 15 min, including a Q & A session with the instructor and the class.

Course Schedule: A Weekly Breakdown

Table 1: Course Calendar

	Topics/Daily Activities	Reading	Homework/Project Deliverables
Week 1	Overview and Disaggregate Demand Models: modeling of choices, preferences, and utility function; basic logit model	[1]: Ch1 [1]: 3.1 – 3.3.2	
Week 2	Disaggregate Demand Models: extreme value model; model estimation; value of time and reliability	[1]: 3.3.5 [2]: 2.1.1, 2.2.2 [2]: 2.2.5, 2.3	Homework 1 out
Week 3	Consumer Theory & Demand Models: demand elasticity, uncertainty, mode choice	[1]: 4.1, 4.2, 4.3.1.2 [2]: 2.2.3, 2.4.5	
Week 4	Demand Models: path choice, trip-chaining, activity-based, freight demand models	[1]: 4.3.3.1, 4.5, 4.7 [2]: 2.6	Homework 1 due Homework 2 out
Week 5	Supply Models: traffic flow theory fundamentals, queuing theory	[1]: , 2.2.1.1, 2.2.1.2 2.2.2.2, 2.2.2.3	Project proposal due
Week 6	Supply Models: network models, flows, cost functions	[1]: 2.3, 2.4.2.2, 2.4.1.2	Homework 2 due Homework 3 out
Week 7	Supply Models: applications to continuous and scheduled services	[1]: 2.4.1.2	
Week 8 (mid term)	Review of basic concepts in optimization	Class notes to be circulated	Homework 3 due Homework 4 out
Week 9	Cost Models: basics of firm theory; cost functions for public	[2]: 3.4.2, 3.5.1 + class notes to be circulated (if needed)	Project interim report due

	transit, dynamic congestion models		
Week 10	Static Traffic Assignment: supply/demand model, network performance, uncongested networks	[1]: 5.1.2, 5.2.1, 5.2.2, 5.3, 5.4.1, 5.4.2	Homework 4 due Homework 5 out
Week 11	Advanced Traffic Assignment: congested networks, dynamic traffic assignment, system optimum	[1]: 5.4.3, 5.4.4, 5.4.5, 5.4.6 [1]: 6.3.1	
Week 12	Pricing: congestion pricing, second best pricing, bottlenecks	[2]: 4.1.1, 4.1.2 (pg 127-131)	Homework 5 due Homework 6 out
Week 13	Pricing and Investment: public transit, subsidies, cost-benefit analysis, demand and cost forecasts	[2]: 4.5, 5.2	
Week 14 (thanksgiving)	Transportation Supply Design: layouts, road vs transit, solution approaches to supply design	[1]: 9.2, 9.3.1, 9.3.3, 9.4.1	
Week 15	Project Presentations		Homework 6 due
FINAL			No final exam; project final report due

Statement on Academic Conduct and Support Systems

Academic Integrity:

The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, comprises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and

could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the university.

For more information about academic integrity see [the student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Students and Disability Accommodations:

USC welcomes students with disabilities into all of the University's educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfrontdesk@usc.edu.

Support Systems:

[Counseling and Mental Health](#) - (213) 740-9355 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

[988 Suicide and Crisis Lifeline](#) - 988 for both calls and text messages – 24/7 on call

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline is comprised of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

[Relationship and Sexual Violence Prevention Services \(RSVP\)](#) - (213) 740-9355(WELL) – 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

[Office for Equity, Equal Opportunity, and Title IX \(EEO-TIX\)](#) - (213) 740-5086

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

[Reporting Incidents of Bias or Harassment](#) - (213) 740-5086 or (213) 821-8298

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

[The Office of Student Accessibility Services \(OSAS\)](#) - (213) 740-0776

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

[USC Campus Support and Intervention](#) - (213) 740-0411

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

[Diversity, Equity and Inclusion](#) - (213) 740-2101

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

[USC Emergency](#) - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

[USC Department of Public Safety](#) - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call

Non-emergency assistance or information.

[Office of the Ombuds](#) - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

[Occupational Therapy Faculty Practice](#) - (323) 442-2850 or otfp@med.usc.edu

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.