

Spring 2023

## **CE 599: Transportation Systems Analysis (4 units)**

Sonny Astani Department of Civil and Environmental Engineering  
University of Southern California

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 production functions, 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.

### **Course Instructor**

Ketan Savla, KAP 254A, 213 740 0670, [ksavla@usc.edu](mailto:ksavla@usc.edu).  
Office hours: Wednesdays 1600-1800, or by appointment

### **Class location, hours, and website**

KAP 165, MW 1000-1150

The class will use the blackboard website at USC, <https://blackboard.usc.edu/>, as the primary medium for distribution of course material and announcements.

### **Prerequisites**

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

### **Grading**

- 30% Homeworks  
There will be a total of six homeworks in this course.
- 30% Midterm exam
- Class project:
  - 5 % Preliminary proposal
  - 10 % Interim report
  - 10 % Project presentation
  - 15 % Final report

The course material will be derived primarily from the following books. Note that [1] can be accessed online via USC libraries.

## ***Required Textbooks***

[1] E. Cascetta. *Transportation Systems Analysis*. Springer, 2009. 4

[2] Kenneth A. Small and Erik T. Verhoef. *The Economics of Urban Transportation*. Routledge, 2 edition, 2007. 4

## **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 or numerical research, write a report and present their results to the class. A good starting point for selecting a case study 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 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. names 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.

## Tentative Course Schedule

The tentative schedule of the course is shown in Table 1. The list of topics expected to be covered during each class are listed below:

1. Introduction and Consumer Theory: Choices, Complexity, Demand Elasticity, Preferences, Utility Function, Consumer Surplus, Uncertainty
2. Discrete Choice Models: Basic Logit Models, Rank-ordered Models, Extreme Value Models, Mixed Logit, Model Estimation, Value of Time and Reliability
3. Demand Modeling: Mode Choice, Path Choice, Trip-Chaining, Activity-based, Freight Transportation Demand Models
4. Supply Modeling: Fundamentals of Traffic Flow Theory, Network Models, Flows, Cost Functions, Application to Continuous Service and Scheduled Service
5. Traffic Assignment: Supply/Demand Model, Network Performance, Assignment for Congested and Uncongested Networks, Basics of Dynamic Assignment
6. Theory of Firm: Production Functions, Profit Maximization and Cost Minimization, Average and Marginal Costs
7. Cost Modeling: Cost Functions for Public Transit, Elements of Cost Studies, Dynamic Congestion Models, Short-Run vs. Long-Run Costs, Intermodal Cost Comparisons
8. Pricing: Congestion Pricing, Second Best Pricing, Network Aspects, Pricing of Parking and Public Transit, Incentive Effects of Subsidies
9. Transportation Supply Design: Design of Layouts, Capacities, Road vs. Transit, Pricing Design, Algorithms for Solving the Design Problems
10. Investment: Capacity Choice for Highways, First-Best and Second-Best Capacities, Cost-Benefit Analysis, Demand and Cost Forecasts, Discounting Future Costs
11. Transportation Providers: Private Highways, Heterogeneous Users, Private Toll Lanes, Private Transit Services, Market Structure, Efficiency of Public and Private Providers
12. Comparison of Transportation System Projects: Impact Factors, Benefit-Cost and Revenue-Cost Analysis, Methods for Impact Analysis

## Statement on Academic Conduct and Support Systems

### Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Section 11, *Behavior Violating University Standards* <https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>. Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the *Office of Equity and Diversity* <http://equity.usc.edu> or to the *Department of Public Safety* <http://adminopsnet.usc.edu/department/department-public-safety>. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of

Week #	Topics	Reading	HW # out	HW # due
1	Overview and Disaggregate Demand Models	[1]: Ch.1 [1]: 3.1 – 3.3.2		
2	Disaggregate Demand Models	[1]: 3.3.5 [2]: 2.1.1, 2.2.2 [2]: 2.2.5, 2.3	1	
3	Consumer Theory & Demand Models	[1]: 4.1, 4.2, 4.3.1.2 [2]: 2.2.3, 2.4.5		1
4	Consumer Theory & Demand/Supply Models	[1]: 4.3.3.1, 4.5, 2.2.1.1, 2.2.1.2 [2]: 2.6	2	
5	Supply Models	[1]: 2.2.2.2, 2.2.2.3		
6	Supply Models	[1]: 2.3, 2.4.1.1, 2.4.1.2		2
7	Supply Models	[1]: 2.4.1.2	3	
8	Mid Term Week (October 10 2022)			3
9	Short vs. Long-run Cost Functions, Static Traffic Assignment	[2]: 3.4.3, 3.5.1 [1]: 5.1.2, 5.2.1, 5.2.2	4	
10	Static Traffic Assignment	[1]: 5.3, 5.4.1, 5.4.2		
11	Advanced Traffic Assignment	[1]: 5.4.3, 5.4.4, 5.4.5, 5.4.6 [1]: 6.3.1	5	4
12	Pricing	[2]: 4.1.1, 4.1.2 (pg 127-131)	6	5
13	Pricing & Investment			6
15	Project presentations			

Table 1: Tentative Course Schedule

another person. The *Center for Women and Men* <http://www.usc.edu/student-affairs/cwm/> provides 24/7 confidential support, and the sexual assault resource center webpage <http://sarc.usc.edu> describes reporting options and other resources.

## Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* <http://dornsife.usc.edu/ali>, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* [http://sait.usc.edu/academicssupport/centerprograms/dsp/home\\_index.html](http://sait.usc.edu/academicssupport/centerprograms/dsp/home_index.html) provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* <http://emergency.usc.edu> will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.