

Fundamentals of Traffic Operations and Control (CIVIL-457)

COURSE INFORMATION

Units: 4

Format: 2 hours of lecture per week + 2 hour of exercise-laboratory per week (on average)

Class Meets: *Lectures:* Wednesday 12.15 – 4.00 pm, Meeting room: CM 1120
Final Exam Type: During the Semester – Written

Prerequisites: “Transportation Systems Engineering” or Consent of the Instructor. Students that haven’t attended the above course are strongly encouraged to follow week 1 and 2 of the Online MOOC Course that provides a good overview of traffic flow basics. Information will be provided in the FTOC course website.

Instructors in Charge

Prof. Nikolas Geroliminis GC C2 389 phone(s): [+41 21 69] 32481

Guest Lecturers: Dr. Jack Haddad, Dr. Patrick Stokkink, Dr. Zhenyu Yang

Teaching Assistants: Pengbo Zhu, Yura Tak, Anne-Valérie Preto

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*Office Hours for all assistants (OH): Thursday 3-4 pm (and by appointment)**

*Office hours is an optional time which gives students the opportunity to ask in-depth questions and to explore points of confusion or interest that were not fully addressed in class.

Course Description

Introduction to fundamentals of urban traffic engineering, including data collection, analysis, and design. Traffic engineering studies, performance measures of freeways and urban streets. Network analysis and simulation. Different levels of traffic modeling, micro- (car following), meso- (link level) and macro- (network level). Design of control

strategies for simple systems. Application of traffic operations. Public Transportation Operations, Intro to Logistics systems and last mile deliveries.

Course Objectives

The objectives of this course are to present the major elements of traffic operations and to develop basic skills in applying the fundamentals of traffic analysis and control. By the end of this course, students should be able to start applying these skills to model different aspects of congestion in urban transportation systems and develop elegant control strategies to improve mobility in cities. The students are also prepared for further study in this field. The course does not cover all aspects of traffic engineering, operations and control. The kinds of recipes found in handbooks, for example, are de-emphasized. Priority is given instead to logic; i.e., ways of thinking about problems that commonly arise in transportation operations so as to obtain suitable solutions. The ideas covered here are those that, by virtue of their grounding in physical reality, are most likely to stand the test of time.

To this end, the course entails four *themes*.

1. Traffic Modeling

Relations between properties of traffic streams and models describing how congestion changes over time and space at different levels of scale.

Micro- (Car following), Meso- (Cell Transmission Model), Macro- (city level)

2. Control of Traffic Signals

Schemes to affect traffic stream properties in some desirable way(s); e.g. coordinating green times at neighboring highway traffic signals to reduce driver delay. Adaptive control, Coordination, Ramp metering

3. Scheduled transportation systems

Basic principles in operating fleets, Allocation of urban space, Design, Instabilities, Bus Bunching. Car Sharing. On-demand transportation. Logistics. Preparation for more advanced study.

Lectures: LUTS has recently developed an online MOOC course on traffic modeling and ITS. Some of the material in the FTOC course are included in the MOOC. Students can

look at the videos of some lectures as supplementary material. Some Weeks lecture will be a MOOC only lecture, where students will watch on their own and then questions will be answered by Prof. Geroliminis and the assistants before the exercise session begins.

Grading

- Labs (2) 30%
- Mid-term (Written) 30%
- Final Exam (Written) 40%
- Exercise (Every week) 0% $\Rightarrow$ (Solutions will be posted online. No Exercise has to be submitted by the students for grading)

The midterm and final exams are closed books. One personal A4 written on both sides is allowed per student.

The final grade is estimated based on the relative performance of all students at each exam.

Textbook

- Lecture notes, book chapters and handouts will be distributed throughout the semester, or posted on web.

Labs (Groups of 2 or 3 students)

- There are 2 lab assignments involving data collection, processing and analysis.
- There are lab assignments utilizing various PC-based traffic engineering analysis

Students are recommended to utilize Matlab or Python in the data analysis. Alternative software can also be used.

All lab reports must be prepared professionally. Each submitted lab report would receive two equally weighted grades: one for technical content and one for report quality. The end product of each lab will be a final report (2 in total) describing the work performed and presenting the project findings. The format of each project report should include:

- Abstract (concise summary of the report)
- Introduction (problem statement)
- Research Approach (methodology)
- Findings (results, interpretation)
- Conclusions (key findings, discussion)
- References
- Appendices

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COURSE SCHEDULE (tentative)

SESSION	DATE	LECTURE	EXERCISE
1	11/9	Introduction System Monitoring and ITS Traffic Flow Revision Intro to MFD	Exercise 1
2	18/9	Network-level Models, MFDs (MOOC lecture) Existence/Physical properties (MOOC lecture) MFD Dynamic Modeling (MOOC lecture)	Exercise 2
3	25/9	MFD Perimeter Control	Exercise 3
4	2/10	Lab # 1 (4hrs)	
5	9/10	Travel Demand Management (Dr. Zhenyu Yang)	Exercise 4
6	16/10	Emissions, Intro to On-demand Transport	Exercise 5
Lab# 1 Due Date: October 29, 2024			
7	30/10	On-demand Transport	Midterm prep
8	6/11	Midterm Exam	Lab #2 (1hr)
9	13/11	Multimodal systems – Parking Congestion Pricing	Exercise 6
10	20/11	Lab # 2 (4hrs)	
11	27/11	Optimization of multi-modal transport and logistics systems (Dr. Patrick Stokkink)	Exercise 7
12	4/12	Transit signal priority – Bus bunching	Exercise 8
13	11/12	Adaptive traffic signal control (Dr. Jack Haddad)	Exercise 9
14	18/12	Final Exam	

Lab# 2 Due Date: January 6, 2025