UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Department of Civil and Environmental Engineering

Francesc Soriguera
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(250ST2132 Traffic)

TRAFFIC

Fall 2017 (Q3)

Format: 5 ECTS – 2 hours of lecture per week + 2 hours of discussion even weeks
Class Meets: Thursday 15 to 17h, A1-206; Tuesday 15 to 17h even weeks, A1-201.
Instructor in Charge: **Francesc Soriguera (FS)**
Other Instructors: **Margarita Martínez, Marcel Sala (GSI)**
Office Hours: Only by appointment. See header for contact information.

General objectives: The course will examine the attributes of highway transportation systems, including traffic flow features and theories. Emphasis will be given to principles and concepts and their application.

Description: The course will address issues regarding freeway/highway traffic operation (i.e. diagnosis). Our discussions will include methods of measuring traffic variables and of processing these measurements to evaluate prevailing conditions, to identify bottleneck locations, to uncover bivariate relations, etc. Considerable discussion will also be devoted to techniques for modeling traffic. This is only the first part of a traffic operations course. Freeway operation and management techniques and highway traffic control (e.g. signal systems) are out of the scope of the course.

Methodology: No textbook is assigned to this course. Rather, the background readings for the course (e.g. portions of monographs, journal publications, etc.) have been compiled into a reader that will be distributed among students. In general, the lectures will follow these materials closely. The professor will typically announce required reading assignments in advance. Ideally you would bring the reader (or suitable portions of it) to each lecture.

The students will be assigned practical exercises to be solved during the course. These will include 5 individual homework assignments and 2 group mini-projects.

- *Homework 1* – Application of Edie's generalized definitions (from loop detector data of individual vehicles)
- *Homework 2* – Bivariate Relations – Processing joint Measurements and constructing diagrams.
- *Homework 3* – Application of Kinematic Wave Theory (using cumulative count curves) to a small freeway system with ramps.
- *Homework 4* – Estimation of delays and queuing caused by an over-saturated (congested) off-ramp.
- *Homework 5* – Use of a refined/modified continuum theory to evaluate conditions created by a "moving bottleneck" with different driver types.

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- *Mini-Project 1* – Identification of freeway bottleneck location(s) and the estimation of bottleneck capacity from actual loop detector data on a freeway stretch.
- *Mini-Project 2* – The Cell Transmission Model: coding the model for a simple freeway system.

Digital Campus: The course reader, the homework assignments, the mini-projects and some additional audiovisual support material will be accessible on the course web site in Atenea. (https://atenea.upc.edu/login/index.php). Those who have not officially enrolled the course yet, can access Atenea as guests. The password for this course is "soriguera".

Student Evaluation and Examination Norms: The final course grade will be derived from the performance on the homework assignments (individual) and mini-projects (in groups). All the activities have the same value. Re-submissions or late submissions (i.e. after the in class correction, whether or not there has been an on-time submission) are accepted until the last session of the course. In this case, the final grade of the activity is obtained as the arithmetic average of the on-time and late submission grades. No submission on-time implies a zero grade for this part of the average. There is no final exam.

Additional Information: The course is grounded on fundamental concepts from classical theories of traffic flow. The application of these theories requires making use of fundamental tools (graphical and analytical) regarding transportation operations (e.g. trajectories diagrams, cumulative curves and queuing theory, measurement and estimation). The development of the course takes this background for granted, as it is acquired in the 1st year of the masters' degree.

Tentative Schedule of Topics:

Date	Week	TOPIC	Readings
21/09	1	Introduction to the course. Traffic variables from trajectories. Edie's generalized definitions. Loop detectors. Discuss TRR 1232 vs 1591. Post HW#1.	1, 2
26/09	2	Discussion #1. Work on HW#1.	-
28/09		Bivariate relationships. Properties of the Fundamental Diagram. Problems when processing joint measurements. Estimating diagrams from data.	3
5/10*	3	Diagnosing freeway conditions. Using N, T curves to identify traffic conditions. Oblique plot of N-Curves. Identifying bottlenecks. **HW#1 is due.** Post HW#2.	4 5 (basics) 6 (application)
10/10	4	Discussion #2. Work on HW#2.	-
19/10*	5	KWT. Overview. Application to inhomogeneous roads. Applying LWR to N-Curves. BOQ curve. **HW#2 is due.** Post MP#1.	7
24/10	6	Discussion #3. Work on MP#1.	-
26/10		Newell's Simplified Theory of KW's (I). 3 detector problem. Newell's notation. Moving time coordinates.	8 (1st part)

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9/11*	7	Newell's Simplified Theory of KW's (II). Examples of application: A single bottleneck; Multiple freeway sections. **MP#1 is due.** Post HW#3.	8 (2nd part)
14/11	8	Discussion #4. Work on HW#3.	-
16/11		CTM Overview. Merging CTM.	9, 10
23/11*	9	Diverging CTM. Known turning ratios; known routes (turning ratios not specified). **HW#3 is due.** Post MP#2.	
28/11	10	Delays and queues at congested off-ramps. Post HW#4.	11, 12
30/11		Discussion #5. Work on MP#2.	-
12/12*	12	Discussion #6. Work on HW#4. **MP#2 is due.**	-
14/12		KWT with different driver types. Moving bottlenecks. Post HW#5.	13, 14
21/12*	13	Discussion #7. Work on HW#5. **HW#4 is due.**	-
26/1	-	**HW#5 is due.**	-

Basic References:

1. Hall, F. L. and B. N. Persaud. (1989). Evaluation of speed estimates made with single-detector data from freeway traffic management systems. *Transportation Research Record* 1232, 9-16.
2. Cassidy, M. J. and B. Coifman. (2007). Relation among average speed, flow and density and analogous relation between density and occupancy. *Transportation Research Record* 1591, 1-6.
3. Cassidy, M. J. (1998). Bivariate relations in nearly stationary highway traffic. *Transportation Research Part B* 32(1), 49-59.
4. Cassidy, M. J. and J. Windover. (1995). Methodology for assessing dynamics of freeway traffic flow. *Transportation Research Record* 1484, 73-79.
5. Muñoz, J. C. and C. F. Daganzo. (2000). Fingerprinting traffic from static freeway sensors. Unpublished.
6. Cassidy, M. J. and R. L. Bertini. (1999). Some traffic features at freeway bottlenecks. *Transportation Research Part B* 33(1), 25-42.
7. Lawson, T.W., D.J. Lovell and C.F. Daganzo. (1997). Using the input–output diagram to determine the spatial and temporal extents of a queue upstream of a bottleneck. *Transportation Research Record* 1572, 140–147.
8. Newell, G. F. (1993). A simplified theory of kinematic waves in highway traffic. Part I: General Theory; Part II: Queuing at freeway bottlenecks. Part III: Multi-destination flows. *Transportation Research Part B* 27(4), 281-313.
9. Daganzo, C. F. (1995). The cell transmission model. Part II: Network traffic. *Transportation Research Part B* 29(2), 79-93.
10. Daganzo, C. F. (Unknown). *Queuing of two conflicting traffic streams*. Unpublished notes from CE150. UC Berkeley.
11. Newell, G. F. (1999). Delays caused by a queue at a freeway exit ramp. *Transportation Research Part B* 33(5), 337-350.
12. Cassidy, M. J. Anani, S. B. and J. M. Haigwood. (2002). Study of freeway traffic near an off-ramp. *Transportation Research Part A* 36(6), 563-572.
13. Newell, G. F. (1998). A moving bottleneck. *Transportation Research Part B* 32(8), 531-537.
14. Muñoz, J. C. and C. F. Daganzo. (2002). Moving bottlenecks: a theory grounded on experimental observation. *Proceedings of the 15th International Symposium on Transportation and Traffic Theory*. Adelaide, Australia.
15. Newell, G. F. (2002). A simplified car-following theory: a lower order model. *Transportation Research Part B* 36(3), 195-205.
16. Daganzo, C. F., M. J. Cassidy and R. L. Bertini. (1999). Possible explanations of phase transitions in highway traffic. *Transportation Research Part A* 33(5), 365-379.
17. Daganzo, C. F. (1999). Remarks on traffic flow modeling and its applications. *Traffic and Mobility*. Brilon, Huber, Schreckenberg and Wallentowitz (Editors). Springer.

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18. Daganzo, C. F. (1995). Requiem for second-order fluid approximations of traffic flow. *Transportation Research Part B* 29(4), 277-286.

Additional References:

– Cassidy, M.J. (1999). *Handbook of Transportation Science*. Chapter 6: Traffic Flow and Capacity. Springer.
– Daganzo, C.F. (1990). *Fundamentals of Transportation and Traffic Operations*. Prentice Hall.
– Homburger, W.S., J.W. Hall, W.R. Reilly and E.C. Sullivan. (2007). *Fundamentals of Traffic Engineering*. 16th Edition. Institute of Transportation Studies, University of California, Berkeley.
– Newell, G.F. (1982). *Applications of Queuing Theory*. Chapman & Hall.
– *Highway Capacity Manual*. (2000). Transportation Research Board. Washington D.C.
– May A.D. (1990). *Traffic Flow Fundamentals*. Prentice Hall.
– *Traffic Engineering Handbook*. 6th Edition (2009). Institute of Transportation Engineers. Washington D.C.