MASTER IN SUPPLY CHAIN, TRANSPORT AND MOBILITY (SCTM)
250ST013 Operations in Transportation

ETSEIB ETSECCPB

Q1

Department:	Civil and Environmental Engineering
Professor:	Francesc Soriguera
Other Instructors:	Margarita Martínez, Marcel Sala-GSI
Type:	Core subject
ECTS Credits:	5

OBJECTIVES

General Objectives

The course will present concepts of transport operations that should be understood by every student of transportation engineering or planning, regardless of his or her background or specific professional interests, and will prepare the student for further study in this field.

Specific objectives

The course focuses on logic, ways of thinking and basic assessment tools (predominantly graphical) suitable in order to obtain solutions to problems that commonly arise in transportation operations. To a large extent, the concepts described in this course are not specific to any one mode (e.g. typically the term "traffic streams" does not refer only to highway vehicles). Rather, we seek to introduce logical ideas relevant to virtually any and all types of transport. The course does not cover all aspects of transport operations. The kinds of recipes found in handbooks, for example, are de-emphasized. The ideas covered in the course are those that, by virtue of their grounding in physical reality, are most likely to stand the test of time, and should be considered fundamentals. We will strive always to distinguish those concepts that are true "by definition" from those involving theory or conjecture.

COURSE DESCRIPTION

1 **Basic Assessment Tools**; predominantly graphical tools useful for understanding details of transport operations. We will briefly discuss optimization techniques.

2 **Flow Theory**; common properties of traffic streams (including flow, density and speed), relations between these properties and models describing how these properties change over time and space.

3 **Flow Control**; 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 or implementing take-off and landing rules at an airport runway to maintain safe spacings between aircraft. Preliminary discussion of transport networks (e.g. paradoxes) is provided here with an eye toward preparing students for more detailed study in other courses and to highlight the complications that can arise network-wide when deploying control schemes.

4 **Observation and Measurement**; the collection and interpretation of transportation data in order to estimate relevant properties of traffic streams (e.g. capacity, average speed, O/D matrix…) accounting for the inherent uncertainty in transport systems.

5 **Scheduled Transportation**; basic principles in operating fleets with schedules. This includes dispatching of vehicles, schedule adherence and control, passenger delays and transfer coordination.

METHODOLOGY

Two hours of lecture per week plus two hours of discussion at odd weeks. Discussion sessions will be devoted to reinforce the concepts presented in the lectures with examples and practical application in problems. The semester lasts a maximum of 15weeks.

The students will be assigned practical exercises to be solved during the course. These will include 3 individual homework assignments and 1 group mini-project.

- *Homework 1* – Basic assessment tools, using space-time diagrams, cumulative count curves, and optimization methods.
- *Homework 2* – Flow theory and control.
- *Homework 3* – Scheduled transportation.

- *Mini-Project 1* – Observation and measurement. Student will be asked to gather data over time regarding some activity of interest; analyze the data, assess the performance of the system and propose improvements.

COURSE EVALUATION

Qualification system

The final course grade (F) will be derived from the performance on the homework assignments and mini-project (H – obtained as the arithmetic average of the grades in all activities) and on the final exam (E). Geometric weighted average will be applied in order to obtain the final grade from both parts, so that: $F=H^{0.4}\cdot E^{0.6}$.

Those who do not pass the course (i.e. F<5), will be able to take a re-evaluation exam (R). In such case, the final exam grade will be obtained as the maximum between (E) and the grade obtained in the re-evaluation exam (R). The maximum final course grade (F) for those taking the reevaluation exam will be 5.0 (over 10).

For those students who consider that they have already acquired the concepts and competences of the course in their previous academic background, there is the possibility of taking a recognition exam (during the first week of October). If they pass this exam (grade >5.0) this could substitute the final course grade (F) if the student wishes so.

Examination norms

In the final exam, students will be allowed to bring one sheet of hand-written notes. No other written or electronic materials will be allowed.

RESOURCES

The homework assignments, the mini-projects and some additional audiovisual support material will be accessible on the UPC Digital Campus 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”.

No textbook is assigned to this course. However the recommended text (Daganzo, 1997) follows closely the concepts presented in the course, with a deeper analysis in many chapters.

Moreover, support material will be posted regularly in Atenea. These will typically include the graphics used in the lecture presentations on the blackboard.

Bibliography

Basic bibliography

1. Daganzo C.F. (1997) *Fundamentals of Transportation and Traffic Operations*. Elsevier, New York.

Complementary bibliography

2. 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.
3. *Highway Capacity Manual* (2010) Transportation Research Board. Washington D.C.
4. Vuchic, V.R. (1981) *Urban Public Transportation: Systems & Technology*. (ch. 7) Prentice Hall, Englewood Cliffs, N.J.

Journal Articles

5. Edie, L.C. (1965). Discussion of traffic stream measurements and definitions. *Proc. Int. Symp. on the Theory of Traffic Flow*, (J. Almond, ed.), pp. 139-154, OECD, Paris.
6. Greenshields, B.D. (1935) A Study of Traffic Capacity. *Highway Research Board Procs* 14, 448-477.
7. Makigami, Y., G.F. Newell and R. Rothery. (1971). Three-dimensional representation of traffic flow. *Transportation Science*, Vol. 5, pp. 302-313.

PROFESSORS AND TUTORIAL SCHEDULING

Professor	e-mail	Building	Office	Time Schedule
F. Soriguera	francesc.soriguera@upc.edu	Campus Nord	B1-114	By appointment
M. Martínez	margarita.martinez@udc.es	Campus Nord	B1-006	By appointment
M. Sala (GSI)	marcel.sala@upc.edu	Campus Nord	B1-006	By appointment

ADDITIONAL INFORMATION

Ch. 4 of the course (Observation and Measurement) is grounded on fundamental probability tools and estimation methods. These concepts are acquired on the complementary course of "Data Gathering and Analysis". The development of the course will take this background for granted, as it is acquired in another required course of the masters' degree.

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OPERATIONS IN TRANSPORTATION (250ST013)

Course Schedule Fall 2017 (Q1)

Format: 5 ECTS – 2 hours of lecture per week + 2 hours of discussion odd weeks
Class Meets: Monday 16 to 18h, H-9.1; Tuesday 17 to 19h, odd weeks, H-9.1.

Tentative Schedule of Topics:

Date	Week	TOPIC	Theme	Readings
18/9	1	Course overview. **Introduction to Transportation Operations.** Components of the transport system. Sample problem: speed of a group of friends.	INTRO	-
19/9		**Time-space diagram.** Trajectories. Examples. Constructing trajectories. Traffic stream properties. Time vs space averages. Traffic fundamental equation.	TOOLS	Ch. 1
2/10	3	**Queuing processes I.** Introduction. Components. Cumulative plots N-t. Input-Output diagrams. Time and accumulation in the system. Little's formula.	TOOLS	Ch. 2
3/10		**Discussion 1.** T-S diagram. Queuing processes. **Mini-Project description**	TOOLS	-
9/10	4	**Queuing processes II.** Constructing queuing diagrams with incomplete information. Design of queuing systems.	TOOLS	Ch. 2
16/10	5	**Queuing processes III.** Stochastic effects. Centralization. Optimization. Psychology of waiting lines.	TOOLS	Ch. 2
17/10*		**Discussion 2.** Solution of HW#1.	TOOLS	-
23/10	6	**Flow conservation.** Introduction to flow theory. Flow conservation equation. Velocity of an interphase. Moving observer.	FLOW THEORY	Section 4.3
6/11	7	**Diagrams & Manuals.** Speed-density models. Fundamental diagram. Newell's triangular simplification. Warning about manuals.	FLOW THEORY	Sections 4.2.1 & 4.2.2
7/11*		**Discussion 3.** Continuum theories. Car following. **Mini-Project proposal submission.**	FLOW THEORY	-
13/11	8	**Continuum Theories.** Free & forced regimes. Traffic dynamics. Continuum theory of traffic. Example of application. Instantaneous speed change simplification. Limitations of continuum theories.	FLOW THEORY	P106-112 P132-133
20/11	9	**Car-Following.** Microscopic traffic analysis. Spacing & reaction time. Car following laws. Traffic stability.	FLOW THEORY	P147-149
21/11 *		**Discussion 4.** Solution of HW#2.	FLOW THEORY	
27/11	10	**Cyclic servers.** The isolated traffic signal. Lost times. Stochastic fluctuations. Webster equation. Coordination.	FLOW CONTROL	P168-176
4/12	11	**Networks I.** Wardrop's principles. Equilibrium. Traffic assignment.	FLOW CONTROL	P198-203
5/12		**Discussion 5.** Networks & flow control. Paradoxes: Braess' paradox. Smith's paradox. Discussion of our network analysis.	FLOW CONTROL	-
11/12	12	**Estimation.** Stochastic processes. Simulation. Statistical estimation. Sample size issues. Estimating bottleneck capacity.	OBS. & M.	P234--245 P254-261
18/12 *	13	**Discussion 6.** Solution of HW#3	FLOW CONTROL.	-
19/12 *		**Mini-Project Presentation.**	-.	-
18/1 *	-	**Final Exam.** (17h)	-	-