UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Department of Civil and Environmental Engineering

Francesc Soriguera
Associate Professor

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(250137 – ENG / English Group)

TRANSPORTATION

Spring 2020 (Q2)

Format: 6 ECTS – 4 hours of lecture per week
Class Meets: Tuesday & Thursday 10.10h to 12h, A1-203
Instructor in Charge: Prof. **Miquel Estrada.** miquel.estrada@upc.edu. Room B1-113
Instructor English Group: Prof. **Francesc Soriguera**. francesc.soriguera@upc.edu. Room B1-114
Other Instructors: Prof. **J. Magín Campos**. magin.campos@upc.edu. Room B1-101
Office Hours: Only by appointment.

General objectives: The course will present concepts of transport planning and 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.

Description: This course introduces tools for the analysis and evaluation of transportation systems, including operations research, traffic flow theory, demand modeling and forecasting, network control and flow assignment. The course emphasizes the knowledge of causal and quantitative performance of transport systems as well as the stakeholders' behavior (users, transport agencies and society). Guidelines for an optimal design, performance and management of terminals and transport infrastructures will be provided. Technical and technological aspects are deemphasized in the course, although innovative applications and their relationship with Information and Communication Technologies are outlined when relevant. The concepts presented in the course will be exemplified by their application in modal interchange terminals for passengers in public transport systems, airport terminals (land- side /air-side management, baggage management system), port terminals (operating container terminals, liquid / solid bulk, ro-ro, etc.), railway terminals, in-land ports, road terminals, freight villages, logistics centers and hubs.

Methodology: Four hours of lecture per week. This includes lectures and discussion sessions. Discussion sessions will be devoted to reinforce the concepts presented in the lectures with examples and practical application in problems. This includes in-class problems to be solved by students. The semester lasts a maximum of 15 weeks. 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.

Digital Campus: The outline for the discussion sessions, the mini-project assignment and some additional audiovisual support material will be accessible on the course web site in Atenea. Password for guests is: **soriguera20**

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Student Evaluation and Examination Norms: The final course grade will be derived from the performance on the in-class assignments (individual), mini-project (in groups) and exams (partial + final). There are 7 discussion sessions with one in-class assignment. Each one is worth 5% of the final course grade, with a maximum of 25% (the best 5 are selected). The course mini-project is worth 25% of the course grade. The remaining 50% is divided between the partial (E1) and final (E2) exams (25% each).

Examination norms: In the exams, students will be allowed to bring one sheet of hand-written notes. No other written or electronic materials will be allowed.

Tentative Schedule of Topics:

Date	Week	TOPIC	Theme	Readings
11/2	1	Course overview. **Introduction to Transportation Operations.** Components of the transport system. Sample problem: speed of a group of friends.	INTRO	-
13/02	2	**Time-space diagram.** Trajectories. Examples. Constructing trajectories. Traffic stream properties. Time vs space averages. Traffic fundamental equation.	(x,t)	Ch. 1
18/2 *	3	**Discussion 1.** T-S diagram	(x,t)	
20/2	4	**Queuing processes I.** Introduction. Components. Cumulative plots N-t. Input-Output diagrams. Time and accumulation in the system. Little's formula.	QUEUE	Ch. 2
25/2	5	**Queuing processes II.** Constructing queuing diagrams with incomplete information. Design of queuing systems.	QUEUE	Ch. 2
27/2	6	**Queuing processes III.** Stochastic effects. Centralization. Optimization. Psychology of waiting lines.	QUEUE	Ch. 2
3/3 *	7	**Discussion 2.** Queuing processes.	QUEUE	
5/3	8	**Flow conservation.** Introduction to flow theory. Flow conservation equation. Velocity of an interphase. Moving observer.	TRAFFIC	Section 4.3
10/3	9	**Diagrams & Manuals.** Speed-density models. Fundamental diagram. Newell's triangular simplification. Warning about manuals.	TRAFFIC	Sections 4.2.1 & 4.2.2
12/3	10	**Continuum Theories.** Free & forced regimes. Traffic dynamics. Continuum theory of traffic. Example of application. Instantaneous speed change simplification. Limitations of continuum theories.	TRAFFIC	P106-112 P132-133
17/3 *	11	**Discussion 3.** Continuum theories.	TRAFFIC	-
23/03 *	12	**Partial EXAM (E1)** 15.00h a 18.00h	EXAM	
26/3	13	Sample solution of Exam E1. **Mini-Project description**	EXAM	
2/4	14	**Microscopic Modelling**. Introduction to microscopic traffic analysis. Spacing & reaction time. Car following laws. Traffic stability.	TRAFFIC	P147-149
14/4 *	15	**Discussion 4.** Microsimulation. **Mini-Project discussion**	TRAFFIC	-
21/4	16	**Scheduled Transportation: user costs.** Small vs large headways. Why stay on schedule? Expected wait time. Transfers design.	SCHED.	P285-295

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23/4	17	**Scheduled Transportation: agency costs.** Model for the trip time. Required vehicles for a route. Headway optimization. Bus capacity assessment. Stochastic effects. Schedule control.	SCHED.	P295-312
28/4 *	18	**Discussion 5.** Scheduled transportation.	SCHED.	-
30/4	19	**Introduction to demand modelling.** 6 steps of the planning process. Demand models. 3 steps of demand modelling. Endogeneity problem & equilibrium solution.	DEMAND	-
5/5	20	**Utility theory.** Demographics & aggregation. Multinomial choice. Elasticity. Summary, problems & solutions.	DEMAND	-
7/5	21	**Random utility models**. Binary logit model. Example of application. Maximum likelihood estimation. Properties of logit models: Elasticity; IIA.	DEMAND	-
14/5 *	22	**Discussion 6.** Demand modelling.	DEMAND	-
19/5 *	23	**Mini-Project discussion.** MP is due.	MP	-
21/5	24	**Networks.** Wardrop's principles. Equilibrium. Traffic assignment.	CONTROL	P198-203
26/5	25	**Network control.** Paradoxes: Braess' paradox. Smith's paradox. Discussion of our network analysis.	CONTROL	-
28/5 *	26	**Discussion 7.** Network control	CONTROL	-
2/6 *	27	**Final Exam (E2).** 15.00h a 18.00h	EXAM	-
17/6 *	28	**Retake Exam (R).** 15.00h a 18.00h	EXAM	

Basic References:

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

Complementary bibliography

General references

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. Hall, R.W. *Handbook of Transportation Science*. Kluwer Academic Publishers. Dordrecht, 2003.
5. Estrada, M. and F. Soriguera. *Sistemes de transport.* Monografies de curs, 2016.

Specific references:

Queuing theory and optimization:

6. Hillier, F. and G. Lieberman. *Investigación de operaciones*. Ed. Mc Graw Hill, 2001
7. Larson, R.C. and A. Odoni. *Urban Operations Research - Logistical and Transportation Planning Methods.* Prentice Hall, 1998.

Traffic

8. May, A.D. *Traffic Flow Fundamentals.* Ed. Prentice-Hall, 1990.

Scheduled transportation

9. Daganzo, C.F. Structure of competitive transit networks. *Transportation Research Part B*, 44(4), 434–446, 2010.
10. Vuchic, V. R. *Urban Public Transportation: Systems and Technology*. John Wiley and Sons, Inc. Hobiken, New-Jersey, 2007
11. Hoel L.A, N. J. Garber, A. Wadid- Sadek.Transportation infrastructure engineering: a multi-modal integration, Nelson Ed. 2008

Demand modelling

12. Ortúzar, J.D. and L. Willumsen. *Modelling transport*. John Wiley & Sons, Inc. 4th edition, 2011
13. Meyer, M. and E. Miller. *Urban Transportation Planning*, Ed. Mc Graw Hill, 2001
14. Oppenheim, N. *Urban Travel Demand Modelling*, John Wiley & Sons, Inc.,1995