250ST2021 - Traffic Simulation Models

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 715 - EIO - Department of Statistics and Operations Research
Academic year: 2019
Degree: MASTER'S DEGREE IN SUPPLY CHAIN, TRANSPORT AND MOBILITY MANAGEMENT (Syllabus 2014). (Teaching unit Optional)
MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Teaching unit Optional)
ECTS credits: 5
Teaching languages: English

Teaching staff
Coordinator: Linares Herreros, María Paz
Others: Montero Mercadé, Lidia

Opening hours
Timetable: Tutorial meetings by appointment.

Prior skills
It would be recommendable that the students have knowledge about transportation modeling, transport demand and traffic flow theory.

In addition, the student must have sufficient knowledge about data analysis methods, as well as prior learning about probability functions and analysis of variance (ANOVA) models.

Degree competences to which the subject contributes
Specific:
CESCTM4. Know and apply the modeling techniques and simulation optimization to solve the problems of design, operation and management of transportation systems.
CETM3. Knowledge for planning, management and operation of transportation systems and mobility, ability to analyze service levels to users, operating costs and environmental and social such as mass transit, and private vehicle traffic impacts, air transport, sea transport, intermodal transport and urban mobility.

Teaching methodology
The course approach will be based on a blending of theoretical concepts and practical issues. Theoretical concepts and practical guidelines will be the main contents of the weekly lectures.

Selected comprehensive collections of papers dealing with the main issues: core models, route choice, dynamic user equilibrium, validation, etc. will be supplied to the students along with practical exercises that will provide a better understanding of the theoretical issues.

The model building methodology is essentially a practical issue that will be taught on basis to modeling exercises during the course which will be done either with open source microscopic simulation software or commercial software, if available.
Learning objectives of the subject

The main objective of this course is to provide to the students the fundamental theoretical knowledge and practical training on the traffic simulation techniques and its applications.

The classical traffic simulation models (microscopic, mesoscopic and macroscopic) are presented and compared, and the main relations among them are analyzed.

The focus of this subject is the microscopic simulation of traffic that is the most powerful and flexible tool for the analysis, design and evaluation of transport systems, especially in urban environments with the presence of the ICT. In particular, the course will explain the main car-following models, as well as lane changing and gap-acceptance models. Discrete choice models and their application to the route choice into the simulator will be also introduced.

In addition, this course will provide a large overview to support the student to perform a proper use of the traffic simulation tools to solve the dynamic network loading and the dynamic traffic assignment problem.

Finally, this subject will pay special attention to the calibration and validation of the traffic simulation models.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours medium group:</th>
<th>30h</th>
<th>24.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
<td>12.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>80h</td>
<td>64.00%</td>
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## Content

<table>
<thead>
<tr>
<th>Block</th>
<th>Introduction to the Traffic Simulation Models: macroscopic, mesoscopic and microscopic approach</th>
<th>Learning time: 19h</th>
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<tbody>
<tr>
<td></td>
<td><strong>Description:</strong> Models, traffic models, simulation and traffic simulation: basic principles and general considerations. Macroscopic models. Mesoscopic models. Microscopic models. Advantages and inconvenient of each approach.</td>
<td>Theory classes: 6h</td>
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<td>Practical classes: 3h</td>
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<td>Self study: 10h</td>
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<table>
<thead>
<tr>
<th>Block</th>
<th>Microscopic Traffic Simulation: Car-Following Models</th>
<th>Learning time: 42h</th>
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<tbody>
<tr>
<td></td>
<td><strong>Description:</strong> Fundamental principles of microscopic traffic simulation models. Time continuous models: Car-Following models. Car-Following models classification: Gazis-Herman-Rothery model, Collision Avoidance models (Gipps, Mahut), Linear models, Desired spacing models. The Newell’s model. The Intelligent Driver Model and its extensions. Introduction to typical lane-changing and gap-acceptance models. Relation among macroscopic and microscopic models.</td>
<td>Theory classes: 8h</td>
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<td>Practical classes: 4h</td>
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<td>Self study: 30h</td>
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<tr>
<th>Block</th>
<th>Route Choice Models and Shortest Path Calculation</th>
<th>Learning time: 14h</th>
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<td></td>
<td><strong>Description:</strong> Discrete choice models. The application of the discrete choice models to choice the route in the simulator. Logit distribution vs C-Logit distribution. K-static shortest path algorithms. Time-dependent shortest path algorithms.</td>
<td>Theory classes: 4h</td>
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<td>Practical classes: 2h</td>
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<td></td>
<td>Self study: 8h</td>
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Block 4. Dynamic Traffic Assignment

**Description:**

Learning time: 23h
- Theory classes: 6h
- Practical classes: 3h
- Self study: 14h

Block 5. Traffic Simulation Experimental Design

**Description:**
Fundamentals of the design of experiments involved in the design of traffic simulation scenarios. Introduction to factorial experimental designs. Fractional factorial design. Results analysis and simulation scenario evaluation.

Learning time: 9h
- Theory classes: 2h
- Practical classes: 1h
- Self study: 6h

Block 6. Calibration and Validation

**Description:**

Learning time: 18h
- Theory classes: 4h
- Practical classes: 2h
- Self study: 12h
The evaluation of the course integrates the two phases of the teaching methodology: theoretical and practical issues.

The theoretical learning is assessed by one quiz and the final exam, in the middle and last week of the course. (Q1 and Q2 qualifications)

The practical issues are assessed from the delivery of different individual practices related to the contents of the course that will include small traffic simulation project.

The final grade will obtained weighing the scores of: Q1, Q2 and the practical part (P):
Final qualification = 0.6Practical (P) + 0.4*(Max{Q2, 0.3Q1+0.7Q2})

Bibliography

**Basic:**


**Others resources:**

- ATENEA:
  - Planning of the subject.
  - Notes related to block contents.
  - Slides presented in weekly lectures.
  - Collections of papers dealing with the main issues.
  - Guidelines for the individual practices.
  - Tasks related to Assignments.