# 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:** 2018  
**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.
The main objective of this course is to provide the students with fundamental theoretical knowledge and practical training on traffic simulation techniques and their 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, which 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 also be 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.

**Learning objectives of the subject**

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**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group: 0h</th>
<th>0.00%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>30h</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
</tr>
<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>80h</td>
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</tbody>
</table>
## 250ST2021 - Traffic Simulation Models

### Content

<table>
<thead>
<tr>
<th>Block 1. Introduction to the Traffic Simulation Models: macroscopic, mesoscopic and microscopic approach</th>
<th>Learning time: 19h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 6h</td>
<td>Practical classes: 3h</td>
</tr>
<tr>
<td>Self study : 10h</td>
<td></td>
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</tbody>
</table>

**Description:**
Models, traffic models, simulation and traffic simulation: basic principles and general considerations. Macroscopic models. Mesoscopic models. Microscopic models. Advantages and inconvenient of each approach.

<table>
<thead>
<tr>
<th>Block 2. Microscopic Traffic Simulation: Car-Following Models</th>
<th>Learning time: 42h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 8h</td>
<td>Practical classes: 4h</td>
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<tr>
<td>Self study : 30h</td>
<td></td>
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</tbody>
</table>

**Description:**

<table>
<thead>
<tr>
<th>Block 3. Route Choice Models and Shortest Path Calculation</th>
<th>Learning time: 14h</th>
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</thead>
<tbody>
<tr>
<td>Theory classes: 4h</td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>Self study : 8h</td>
<td></td>
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</tbody>
</table>

**Description:**
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.
### Block 4. Dynamic Traffic Assignment

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

**Description:**  

### Block 5. Traffic Simulation Experimental Design

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

**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.

### Block 6. Calibration and Validation

**Learning time:** 18h  
Theory classes: 4h  
Practical classes: 2h  
Self study: 12h

**Description:**  
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**Qualification system**

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 be obtained weighing the scores of: Q1, Q2 and the practical part (P):

$$ \text{Final qualification} = 0.6 \times \text{Practical (P)} + 0.4 \times (\text{Max}\{Q2, 0.3Q1+0.7Q2\}) $$

**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.