COURSE DESCRIPTION

1. GENERAL INFORMATION

SCHOOL	CIVIL ENGINEERING		
DEPARTMENT			
EDUCATION LEVEL	Undergraduate		
COURSE CODE	1166	**SEMESTER**	9
COURSE TITLE	Analysis Methods in Traffic Engineering		

COURSE UNITS *In case the credit points are awarded for work completed during discrete parts of the course e.g. Lectures, Laboratory sessions etc. If the credits are awarded for the course as a whole, indicate the weekly teaching hours and the total number of credits / ECTS*	**HOURS**	**ECTS CREDITS**
	4	5
Add rows if necessary. The teaching plan and methods used are described in detail in 4.		

COURSE TYPE: *General, Concentration, Elective*	ELECTIVE COURSE
PREREQUISITE KNOWLEDGE:	Traffic Flow, Urban Road Networks
COURSE AND EXAMS LANGUAGE:	Greek (or in English for Erasmus students)
COURSE OFFERED TO ERASMUS STUDENTS:	YES
COURSE WEBSITE (URL):	https://helios.ntua.gr/course/view.php?id=1594

2. LEARNING OBJECTIVES

Learning Objectives

The learning objectives of the course are described as the level of the specific knowledge, skills and competences that students will acquire after successful completion of the course.
Consult Annex A

- *Description of the Learning Outcomes for each cycle of study according to the Qualifications Framework of the European Higher Education Area*
- *Descriptive Indicators for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Annex B*
- *Comprehensive Guide for Writing Learning Outcomes*

Upon successful completion of the course, students will be able to:

1. know the basic categories of analysis and simulation methods applied in traffic engineering,

2. realize the influence of analytical methods in modern intelligent traffic control and management systems,

3. understand the importance of open-source software and programming tools in solving problems in traffic engineering,

4. develop code for implementing models to solve traffic flow problems; and

5. evaluate traffic models in terms of their usefulness and reliability.

6. combine knowledge to develop integrated traffic analysis and forecasting models and

7. deepen their understanding of traffic analysis and forecasting in a self-reliant manner.

General abilities

Taking into account the general competences that the graduate should have acquired (as indicated in the Diploma Annex and listed below) which of these is/are addressed in the course?

Search, analysis and synthesis of data and information, including the use of the necessary technologies
Adaptation to new decision-making situations
Working independently
Working in teams
Working in an international environment
Working in an interdisciplinary environment
Generating new research ideas

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- Gathering, analysis, and synthesis, using the necessary technologies to solve advanced traffic flow problems in networks.
- Independent work in solving the semester assignments.
- Group work within the context of conducting traffic analyses.
- Exercise of critical and self-critical thinking during the lectures and oral examination of the semester.
- Promotion of free, creative, and inductive thinking during the lectures and oral examination of the semester.

3. COURSE DESCRIPTION

The course introduces advanced concepts for the development of traffic flow models in the context of intelligent traffic control and management systems. The course includes topics such as computer-based traffic control systems; analytical traffic models; traffic simulation models and their applications; queuing theory models; machine learning models for traffic flow analysis and short-term traffic forecasting. The applications are developed in open-source Python programming languages and traffic simulation environment (SUMO). The course provides 4 weekly hours of theory and exercises. In the exercise hours, examples are developed to support the understanding of the course's subject. It is noted that there is no clear distinction between Theory and Exercises since during the theory, examples of exercises are given and during the exercises, questions about the theory are addressed. The students form a single class. The course includes 4 compulsory exercises and an oral examination.

The syllabus includes the following:

- Intelligent Traffic Systems (Introduction. Traffic Management and Traffic Control Systems and Traffic Management Systems. Traffic Control and Traffic Management Procedures. Traffic Forecasting)
- Advanced Traffic Flow Models (Hydrodynamic models. Vehicle following standards. Cellular automata. Traffic at weaving section. Applications.)
- Queueing Theory (Basic Concepts. Estimation of queues and delays, Characteristic queue sizes. Types of queues. Queuing models. Applications in traffic engineering.)
- Traffic simulation (Basic concepts. Simulation models. Traffic signal optimization. Traffic simulation in urban networks. Applications.)
- Machine learning models (Principles of machine learning. Introduction to Python's open-source machine learning libraries. Machine Learning applications in traffic engineering (regression, classification and prediction).

4. TEACHING METHODS – STUDENT ASSESSMENT

TEACHING METHODS: *On-site, on-line etc.*	Lectures on-site Code development and implementation in the lectures Completion and submission of 4 individual assignments.
TEACHING MEDIA: *Use of ICT in teaching, laboratory training, communication with students*	Presentations on the Board. Power Point slides. Computations with open source programming languages (Python) and open source traffic simulation software (SUMO).

COURSE ARRANGEMENT: *Detailed description of the teaching methods.*	***ACTIVITY***	***IMPORTANCE***
Lectures, Seminars, Laboratory Exercises, Field Exercises, Review & Analysis of Literature, Tutoring, Practical, Internships, Clinical Exercises, Artistic Workshops, Interactive teaching, Educational visits, Projects, Writing papers / assignments, Artistic creation, etc. *The student's study hours for each learning activity as well as the hours of unguided study are indicated so that the total workload at semester level corresponds to the ECTS standards.*	On-site lectures Exemplarily solved problems. Model development and implementation in class as part of the lecture.	4*13=52
	Project submissions. Students individually prepare and deliver 4 predefined tasks using Python and SUMO. Each student individually submits the 3 assignments, which are graded by the instructors and then returned during the oral examination.	4*22=88
	Study and preparation for the oral examination	12
	OVERALL:	**152**
STUDENT ASSESSMENT: *Description of the evaluation process.* *Evaluation Language, Evaluation Methods, Formative or Inferential, Multiple-Choice Test, Short Answer Questions, Long Answer Questions, Problem Solving, Written Work, Reports/ Papers, Oral Examination, Public Presentation, Laboratory Project, Clinical Examination of a Patient, Artistic Interpretation, Other / Others* *Mention explicitly defined criteria and if and where they are accessible to students.*	Language of evaluation: Greek (for Erasmus students: English) The final grade of each student is based solely on the grades of the assignments and the oral examination at the end of the semester.	

5. TEXTBOOKS – BIBLIOGRAPHY

-Recommended Publications:
-Relevant scientific journals:

Textbooks

"Traffic Flow", J. Frantzeskakis – M. Pitsiava-Latiopoulou, D. Tsampoulas, 2008.
"Applications of Queueing Theory in Traffic Engineering", JC Golias and MG Karlaftis, 2004.

Recommended Publications

Traffic Flow and Coordinated Traffic Signalization

- Chowdhury, D., Santen, L. and Schadschneider A., (2000).
- Daganzo C. F., (1997). "Fundamentals of transportation and traffic operations." Pergamon, ISBN 0-08-042785-5.
- Hall F. D., (1994), Traffic Stream Characteristics, Monograph on Traffic Flow Theory Institute of Transportation Engineers (ITE) (1993). Traffic Engineering Handbook. Editor Pline, J. L., Prentice Hall, Englewood Cliffs, N. J., 07632, ISBN 0139267913.
- May, A. D. (1990). Traffic Flow Fundamentals. Prentice-Hall Englewood Cli_s, NJ. Mc Shane, W. R., and Roess, P. (1990). Traffic Engineering. Prentice Hall, Englewood Cliffs, N. J., 07632, ISBN 0139261486.
- Papageorgiou M. (2003). Traffic Control. In Handbook of Transportation Science. Ed. R. W. Hall, Kluwer Academic Pub , ISBN: 1402072465.
- Salter R. J. Housell N. B. (1996). Highway Traffic Analysis and Design 3rd edition Palgrave McMillan, ISBN.

Statistical Analysis

- Robert H. Shumway, David S. Stoffer (2000) Time series analysis and its applications: with R examples / New York ; Berlin : Springer.
- Simon P. Washington, Matthew G. Karlaftis, Fred L. Mannering (2003) Statistical and econometric methods for transportation data analysis. Boca Raton : Chapman & Hall/CRC Press.

Traffic Forecasting

- Hyndman, R. J., & Athanasopoulos, G. (2014). Forecasting: principles and practice. OTexts.
- Vlahogianni, E I., Karlaftis, M. G., Golias, J.C. (2014). Short-term Traffic Forecasting: Where We Are and Where We're Going. Transportation Research Part C: Emerging Technologies, 43(1), 3-19.
- Friedman, J., Hastie, T., & Tibshirani, R. (2001). The elements of statistical learning (Vol. 1). Springer, Berlin: Springer series in statistics.

Machine Learning

- Marsland, S. (2014). Machine learning: an algorithmic perspective. CRC press.
- Kruse, R., Borgelt, C., Klawonn, F., Moewes, C., Steinbrecher, M., & Held, P. (2013). Computational intelligence: a methodological introduction. Springer Science & Business Media.
- Engelbrecht, A. P. (2007). Computational intelligence: an introduction. John Wiley & Sons.
- TRB (2007). Artificial Intelligence in Transportation: Information for Application, Transportation Research Circular E-C113, Transportation Research Board, Washington DC.
- Bishop, C. M. (2006). Pattern recognition and machine learning. Springer.

Scientific Journals

- Transportation Research Part B: Methodological, Part C: Emerging Technologies, Part A: Policy and Practice, Part F: Traffic Psychology and Behaviour, Part D: Transport and Environment
- Transportmetrica A: Transport Science, B
- ASCE Journal of Transportation Engineering, Part A: Systems