Department of Railway Transport
Chair of Railway Transport Safety

UNIVERSITY OF ZAGREB
FACULTY OF TRANSPORT AND TRAFFIC SCIENCES

GRADUATE STUDY: TRANSPORT

SEMESTER (II)

Syllabus

Academic year 2023/2024

Course: **Railway Intelligent Transportation Systems**						
Head of course: Assoc. Prof. **Hrvoje Haramina**, Ph.D.						
Co-lecturers: Matea Mikulčić mag. ing. traff.						
Semester: **II**	Course code: **62804**	Lectures: **30**	Seminars: **20**	Auditory exercises: **5**	Laboratory exercises: **5**	ECTS credits: **5**
Group for lectures and seminars:				Group for auditory and laboratory exercises:		

Objective of the course:

- The course aims to introduce students to the area of artificial intelligence and its implementation in train and traffic control processes.

Learning outcomes:

At the end of the course students will:

1. Describe the development and application of artificial intelligence within railway traffic
2. Explain the application of expert systems and decision support systems within the framework of the train and traffic control
3. Create fuzzy inference systems for application in rail traffic
4. Analyse the impact of intelligent transportation systems on the improvement of railway traffic processes
5. Explain the model of anticipated railway traffic management system
6. Evaluate different methods of artificial intelligence designed to solve optimization problems related to railway traffic management

LECTURES, EXERCISES and SEMINARS

Week	Syllabus	Form of classes	Performed by	Lessons	Remark
1.	▪ Introduction to the Area of Artificial ▪ Intelligence, Introduction of Fuzzy Sets ▪ Fuzzy Logic and Fuzzy Control Systems	L	Hrvoje Haramina	4	
2.	▪ Introduction to MATLAB software system ▪ Introduction to Fuzzy logic using MATLAB	AE	Matea Mikulčić	4	
3.	▪ Centralized Traffic Control ▪ Advanced Train Control Systems ▪ Train Driver Support Systems	L	Hrvoje Haramina	4	
4.	▪ Examples of Fuzzy Inference Systems with application in Railways (System for Assessment of Necessary Dwell Time for Urban Trains)	S	Matea Mikulčić	4	
5.	▪ Application of Expert Systems in Train and Traffic Control Processes, ▪ Automation of Train and Traffic Control Processes	L	Hrvoje Haramina	4	
6.	▪ Examples of Fuzzy Inference Systems with application in Railways (Fuzzy System for Automatic Braking of Train)	S	Matea Mikulčić	4	
7.	▪ Examples of Fuzzy Inference Systems with application in Railways (Fuzzy System for Automatic Braking of Train)	S	Matea Mikulčić	2	
	▪ Introduction to Matlab Simulink Tool	AE	Matea Mikulčić	1	

	▪ Introduction to Matlab Simulink Tool	LE	Matea Mikulčić	1	
8.	▪ Train and Traffic Control in Railway Station - Development of Fuzzy Inference Systems in Rail Traffic Control Processes	L	Hrvoje Haramina	4	
9.	▪ Example of Fuzzy Inference System for Traffic Control in Railway Station	S	Matea Mikulčić	4	
10.	▪ Evaluation of Fuzzy Inference System for Traffic Control in Railway Station with OpenTrack Simulation Tool	S	Matea Mikulčić	4	
11.	▪ Evaluation of Fuzzy Inference System for Traffic Control in Railway Station with OpenTrack Simulation Tool	S	Matea Mikulčić	2	
	▪ Introduction to Genetic Algorithms	L	Hrvoje Haramina	2	
12.	▪ Railway Timetable Rescheduling by Application of Genetic Algorithms	L	Hrvoje Haramina	2	
	▪ Introduction to Genetic Algorithms using MATLAB, Railway Timetable Rescheduling by Application of Genetic Algorithms	LE	Matea Mikulčić	2	
13.	▪ Introduction to Neural Networks	L	Hrvoje Haramina	2	
	▪ Introduction to Neural Networks using MATLAB	LE	Matea Mikulčić	2	

14.	▪ Moving Block System ▪ Possibility of Application of Neural Networks in Rail Traffic Control Processes	L	Hrvoje Haramina	4	
15.	▪ Anticipated Rail Traffic Management Systems Based on Railway Intelligent Transportation Systems (RITS)	L	Hrvoje Haramina	4	

L = Lectures; **AE** = Auditory Exercises; **LE** = Laboratory Exercises; S = Seminars

STUDENT OBLIGATIONS AND EXAMS

Conditions for obtaining signatures:

Attendance is mandatory and students are required to attend at least 70% of the classes. In addition, at the end of the course students are required to write and present their seminar paper and to oral examination.

Seminar work (mandatory): The students independently prepare a seminar work, independently studying the recent professional and scientific literature, and finally present their seminar work.

Oral exam:
Students are required to answer questions in such a way so as to demonstrate sufficient knowledge of the subject matter in order to pass the oral exam.

LITERATURE

a) Obligatory literature:

1. H. Haramina: Railway Intelligent Transportation System, Faculty of Transport and Traffic Sciences, Zagreb, 2012.
2. J. Pachl: Railway Operation and Control 3nd edition, VTD Rail Publishing, Mountlake Terrace (USA), 2009.
3. I.A. Hansen, J. Pahl: Railway Timetable & Traffic – Analysis – Modelling - Simulation, EURAIL PRESS 2008.
4. Dokumenation for computer program OpenTrack

b) Recommended literature:

1. W. Mücke: Operations Control Systems in Public Transport, Siemes, 2002.

METHODOLOGY OF THE IMPLEMENTATION OF THE COURSE PLAN

1. LECTURES

In the course of the lectures the theoretical framework of the curriculum is presented and followed by practical examples.

2. SEMINAR

In the course of the seminar examples of railway intelligent transportation systems are presented and discussed.

3. AUDITORIAL EXERCISES

Auditory exercises are performed in a way where work in different specialized software solutions for modelling and testing of railway intelligent transportation systems is presented to students.

4. LABORATORY EXERCISES

Laboratory exercises are performed in the laboratory in a way that students create models of railway intelligent transportation systems in specialized software.

5. DOCUMENTATION

Attendance list is signed by students prior to every lecture.

6. SCORING SYSTEM

Table 1 The credit values in ECTS credits

Activity	ECTS credits
Lectures	**2**
Oral exam	**2**
Seminar	**1**
In total:	**5**