SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	Babes-Bolyai University of Cluj-Napoca
1.2 Faculty	Faculty of Mathematics and Computer Science
1.3 Department	Department of Computer Science
1.4 Field of study	Computer Science
1.5 Study cycle	Master's degree
1.6 Study programme / Qualification	Applied Computational Intelligence

2. Information regarding the discipline

2.1 Name of the discipline (en) (ro)			Introduction to Automated Driving Introducere in sisteme automate de asistenta a conducatorilor auto				
2.2 Course coordinator			Bosch				
2.3 Seminar coordinator			Bosch				
2.4. Year of study	1	2.5 Semester	2	2.6. Type of evaluation	E	2.7 Type of discipline	Optional
2.8 Code of the discipline	MME8160						

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	4	Of which: 3.2 course	2	3.3 seminar/laboratory	1 sem + 1 pr
3.4 Total hours in the curriculum	56	Of which: 3.5 course	28	3.6 seminar/laboratory	28

Time allotment:	hours
Learning using manual, course support, bibliography, course notes	23
Additional documentation (in libraries, on electronic platforms, field documentation)	31
Preparation for seminars/labs, homework, papers, portfolios and essays	35
Tutorship	4
Evaluations	4
Other activities:	12

3.7 Total individual study hours	119
3.8 Total hours per semester	175
3.9 Number of ECTS credits	7

4. Prerequisites (if necessary)

4.1. curriculum	• Computer Programming, Calculus, Linear Algebra, Data structures and algorithms, Artificial intelligence
4.2. competencies	• Mathematics, Programming, Analytical understanding

5. Conditions (if necessary)

5.1. for the course	• N/A
5.2. for the seminar /lab activities	• The presence to application classes is mandatory

6. Specific competences

Professional competencies	C1: Operating with basic concepts of mathematics, physics, measurement science, mechanical engineering, chemical engineering, electrical engineering in systems engineering C2: Operating with basic concepts of computer science, information technology and communication C3: Operating with fundamentals of control engineering, process modelling, simulation, identification and analysis methods, and computer aided design. C4: Design, implementation, testing, operation and maintenance of systems with generic and dedicated equipments, including computer networks for control engineering and applied informatics. C5: Development and implementation of automatic control structures and algorithms based on project management principles, software environments and technologies based on microcontrollers, signal processors, programmable logic controllers and embedded systems.
Transversal competencies	CT1 Aplicarea regulilor de muncă organizată şi eficientă, a unor atitudini responsabile faţă de domeniul didactic-ştiinţific, pentru valorificarea creativă a propriului potenţial, cu respectarea principiilor şi a normelor de etică profesională CT3 Utilizarea unor metode şi tehnici eficiente de învăţare, informare, cercetare şi dezvoltare a capacităţilor de valorificare a cunoştinţelor, de adaptare la cerinţele unei societăţi dinamice și de comunicare în limba română și într-o limbă de circulație internațională

7. Disciplines objectives (**as results from the *key competences gained***)

7.1 General objective	• Development of skills for algorithm development in the area of autonomous driving
7.2 Specific objectives	• Understanding the technology and strategies used for autonomous driving • Implementation of algorithms for perception and sensor data fusion • Implementation of planning and motion control algorithms • Have an overview of safety concepts used in autonomous vehicles • Get an overview on connectivity in vehicles

8. Content

8.1 Lecture (syllabus)	Teaching methods	Remarks
1. Introduction in automated driving (1 course) 2. Ultrasonic and electromagnetic sensors (1 course) a) Ultrasonic - Physical principles of operation of ultrasonic sensors - Applications where the sensor is best to be used (technologies for driver assistance systems based on ultrasonic sensors)	Slides presentation, explanations and demonstrations, discussions, case studies	

b) LiDAR - Principles of operation and examples - Applications where the sensor is best to be used c) RADAR - Sensor model - Applications where the sensor is best to be used		
3. Video sensor (3 courses) a) Image processing basics - Image transformations - Image filtering in spatial and frequency domain - Edge detection b) Computer vision basics - Image representation & acquisition - Camera model - Distortion correction c) Stereo video processing - Epipolar geometry basics - Stereo camera model - Rectification - Disparity estimation d) Optical flow		
4. Classification and object detection (3 courses) a) Machine Learning review - Supervised learning - Unsupervised learning - Reinforcement learning b) Deep Learning - Relation to machine learning - Deep feedforward networks (cross entropy, regularization, dropout) - Back propagation - Convolutional neural networks - Recurrent neural networks - Examples of DNN architectures		
5. Sensor data fusion for perception and localization (2 courses) - State estimators and Kalman filter - Extended Kalman filter - Fusion of video and RADAR sensors data - GPS and odometry fusion for localziation - Localization techniques & precise mapping - Extended Kalman filter based SLAM using landmarks - Graph based SLAM - Loop closure		
6. Path planning and motion control for automated driving (2 courses) a) Configuration Space - Mathematical background review b) Ackerman Model - Motivation of differential model - Demonstration of the model - Extension of the model - State space for extended model - Motivation of state space - Mapping to configuration space c) Sampling-based Algorithm		

- Overview of the sampling based algorithm - Based Sampling Theory Knowledge - Discreet Ackerman Model - Exploration process - Exploring over a grid – A*, polynomial fitting, constrain polynomial to Ackerman model - Exploring by Rapidly exploring dense trees		
7. Connectivity (2 courses) • Introduction to connectivity and cloud computing • Big data analytics methods for automated driving		
Bibliography IEEE Explore articles on autonomous driving (shared on the courses) Automation: From Driver Assistance Systems to Automated Driving, VDA, 2015 Automotive handbook, Robert Bosch GmbH, 2007		
8.2 Applications/Seminars	Teaching methods	Notes
L 1. Introduction and overview L 2. Application with ultrasonic sensors		
L 3. Application with video sensors – part1 L 4. Application with video sensors – part2		
L 5. Object detection applications – part 1 L 6. Object detection applications – part 2		
L 7. Detection of free space and obstacles – part1 L 8. Detection of free space and obstacles – part 2		
L 9. Kalman filters – part 1 L 10. Kalman filters – part 2		
L 11. Path planning – part I L 12. Path planning – part II		
L 13. Application on connectivity and data analytics		
Bibliography Will be shared at each laboratory		

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- The content of the course and applications is developed together with an Automotive Company.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	Evaluation of the acquired skills, activity within lectures	Exam	70 %
10.5 Seminar/lab activities	Evaluation of the practical skills, activity within laboratory classes	Test and/or evaluation of activity	30%
10.6 Minimum performance standards			
➢ Exam grade >5, laboratory grade>5			

Date of filling in Teachers in charge of course Teachers in charge of seminars

18.04.2018

Date of approval in the departments Head of department

..... Prof. Dr. Andreica Anca