FERIT
FAKULTET ELEKTROTEHNIKE, RAČUNARSTVA
I INFORMACIJSKIH TEHNOLOGIJA **OSIJEK**

Proposition of the graduate university study programme in Automotive Computing and Communications

(pursuant to the form for Proposition of the study programme)

Osijek, 2017
(version 2017/2018)

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1 INTRODUCTION

The undergraduate university study programme in Electrical Engineering and the undergraduate university study programme in Computer Engineering have been carried out at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek (hereinafter FERIT) since the academic year 2005/2006. The graduate university study programmes in Electrical Engineering and Computer Engineering have been carried out since the academic year 2008/2009 (see Appendix 7.9). The undergraduate professional study programme in Electrical Engineering, branches Automation, Power Engineering and Informatics, has been carried out since the academic year 2005/2006.

After nearly ten years of carrying out the graduate university study programme and considering the interest and the needs of labour market, wider social community, students' interest and employees' scientific advancement, we have decided to propose a new graduate university study programme in Automotive Computing and Communications. The study programme is based on the scientific fields of Electrical and Computer Engineering; the fields in which the Faculty has a long-time experience in carrying out the undergraduate and graduate university study programmes

1.1 Provide general information about the higher education institution (name, address, telephone number, e-mail, website).

Name of the higher education institution:
Josip Juraj Strossmayer University of Osijek
Faculty of Electrical Engineering, Computer Science and Information Technology Osijek

Address:
Kneza Trpimira 2b
31 000 Osijek

Telephone:
+385 31 224 600

E-mail address:
etf@etfos.hr

Website:
http://www.ferit.hr

1.2 Who approved the initiation of amendments to the study programme (e.g. management boards, faculty council, etc.)? Provide evidence.

The Council of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek adopted the report entitled “Proposition of the graduate university study programme in Automotive Computing and Communications” at its 197th session held on 2nd May 2017 (the Faculty Council decision is provided in Appendix 7.1).

2 INSTITUTIONAL ASSUMPTIONS

2.0 Report on the study programme has to comprise a comparison analysis of the proposed study programmes with related accredited study programmes carried out in the Republic of Croatia or European Union. The analysis has to include the minimal institutional assumptions.

The proposed graduate university study programme in Automotive Computing and Communications is the first such study programme in the Republic of Croatia, hence it cannot be compared to study programmes carried out in the Republic of Croatia. However, since it is based on the scientific fields of Electrical and Computer Engineering, it is partly comparable to the following graduate university study programmes:

- graduate university study programme in Computing at the Faculty of Electrical Engineering and Computing, University of Zagreb (http://www.fer.unizg.hr/studiji/diplomski_studiji/rac). To illustrate, the learning outcomes of the proposed study programme are greatly comparable to the learning outcomes of the following courses: Protection and Security of Information Systems, Basic Use of Linux Operating System, Real-Time Systems, Digital System Design, Operating Systems for Embedded Computers, Embedded System Design, Digital Signal Processing, Computer Vision, Project Management, Distributed Software Development, Pattern Recognition, Machine Learning, Digital Image Processing Analysis.

- graduate university study programme in Information and Communication Technology at the Faculty of Electrical Engineering and Computing, University of Zagreb (http://www.fer.unizg.hr/diplomski_studij/ict). To illustrate, the learning outcomes of the proposed study programme are greatly comparable to the learning outcomes of the following courses: Digital Signal Processing, Communication Protocols, Pattern Recognition, Protection and Security of Information Systems, Computer Vision, Basic Use of Linux Operating System, Signal Processing in Communications, Digital Image Processing Analysis, Machine Learning, Project Management, Embedded Systems.

- graduate study programme in Electrical Engineering and Information Technology at the Faculty of Electrical Engineering and Computing, University of Zagreb (http://www.fer.unizg.hr/diplomski_studij/eit). To illustrate, the learning outcomes of the proposed study programme are greatly comparable to the learning outcomes of the following courses: Digital Image Processing Analysis, Embedded System Design, Control of Power Converters, Power Electronics, Real-Time Systems, Digital Signal Processing, Operating Systems for Embedded Computers, Embedded System Design, Project Management, Basic Use of Linux Operating System.

- graduate study programme in Electrical Engineering, branch Electronics and Computer Engineering, at the Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split (https://nastava.fesb.hr/nastava/studiji/90/god/1). To illustrate, the learning outcomes of the proposed study programme are greatly comparable to the learning outcomes of the following courses: Digital Systems Projecting, Digital Signal Processing Systems, Distributed Information Systems, Video Communication Technologies.

- graduate study programme in Computing at the Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split

(https://nastava.fesb.hr/nastava/studiji/90/god/1). To illustrate, the learning outcomes of the proposed study programme are greatly comparable to the learning outcomes of the following courses: Digital Systems Projecting, Embedded Systems, Digital Image Processing and Analysis.

- graduate study programme in Computing at the Faculty of Engineering, University of Rijeka (http://www.riteh.uniri.hr/obrazovanje/diplomski-sveucilisni-studij/elektrotehnika/). To illustrate, the learning outcomes of the proposed study programme are greatly comparable to the learning outcomes of the following courses: Object Oriented Programming, Embedded Systems Programming, Project Management, Digital Image Processing, Machine Learning.

It is important to emphasise that this is not the first graduate university study programme oriented to computer and electrical engineering, electronics and information technology in the Republic of Croatia. The following study programmes in the field of maritime studies have the similar approach:

- graduate university study programme in Marine Electrical Engineering and Information Technologies at the University of Rijeka (http://www.pfri.uniri.hr/hr/studij/diplomski-studij/eitp)
- graduate university study programme in Marine Electrical Engineering and Communication Technologies at the University of Dubrovnik (http://www.unidu.hr/odjeli.php?idizbornik=143)
- graduate university study programme in Marine Electrical Engineering at the University of Split (http://www.pfst.unist.hr/hr/buduci-studenti/diplomski-studiji/2012-01-30-04-32-56)

The study programme is comparable with the following graduate university study programmes carried out at European universities (see Chapter 3.21 for a detailed comparison):

- Automotive Systems - HAN University of Applied Sciences (https://www.han.nl/opleidingen/master/en/automotive-systems/);
- Automotive Engineering - Universitat Politècnica de Catalunya (https://automocio.masters.upc.edu/en/general-information);
- Automotive Engineering – double degree jointed offered by (http://www.emae.eu/study-program): Czech Technical University in Prague, TU Chemnitz, IT Bandung, HAN University of Applied Sciences, ENSTA Bretagne;
- Automotive Electronics - Technical University of Ostrava (https://www.vsb.cz/en/ects/course-units/usp/?branchId=557#);
- Automotive Systems - Esslingen University of Applied Sciences (https://www.hs-esslingen.de/en/the-university/faculties/graduate-school/masters-programs/meng-in-automotive-systems.html);
- Automotive Electronics - TH Deggendorf (https://www.th-deg.de/de/et-mt/studiengaenge/ae-m).

The study programmes are completely comparable because they last for two years, students acquire the same number of ECTS credits (120) and the academic title of the Master of Automotive Computing and Communications will be recognised in the labour market as the title related to the scientific fields of Electrical and Computer Engineering the study programme is based on.

In addition to other Faculty employees, the teaching process quality will be ensured by 59 teachers and associates affiliated to four Faculty departments that will mainly be involved in teaching classes as follows:

- Department of Computer Engineering and Automation which consists of the Chair of Computer Engineering and the Chair of Automation and Robotics;

- Department of Software Engineering which consists of the Chair of Programming Languages and Systems and the Chair of Visual Computing;
- Department of Communications which consists of the Chair of Radiocommunications and Telecommunications, Chair of Electronics and Microelectronics and the accredited Laboratory for High Frequency Measurements;
- Department of Electromechanical Engineering which consists of the Chair of Fundamentals of Electrical Engineering and Measurements, Chair of Electric Machines and Power Electronics and Electric Machines and Hybrid Electric Drives Laboratory.

High quality computing, measuring and simulation equipment is provided in these Departments. The equipment has already been and will be used in the teaching laboratories. A special emphasis should be placed on the approved project entitled *Modernizing laboratories for innovative technologies* (Interreg-IPA CBC Croatia-Serbia, priority axis *Enhancing competitiveness and developing business environment in the programme area*, lead beneficiary: Faculty of Technical Sciences Novi Sad, project partner: Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, project duration: 1st May 2017 – 1st October 2019) whose resources will be used to equip two laboratories at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek in the total value of 2,000,000.00 HRK. The laboratories will be used for the following fields of the proposed study programme: software architecture for safety-critical controlling systems, methods and techniques for automotive software testing, digital image and video processing for autonomous vehicles, machine learning in autonomous and connected vehicle systems.

The existing quality assurance system should also be stressed, which refers to the teaching process at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, i.e. continuous monitoring and assessment of student performance, student questionnaires evaluating the teaching process and teacher performance as well as other action plans and continuous activities to improve the quality of the studies.

Based upon the comparison of the proposed study programme, it can be concluded that there is a high level of compatibility of this study programme with the study programmes considered, which will certainly facilitate the flow of students between the University of Osijek and both other Croatian universities and most European universities.

3 GENERAL INFORMATION ON THE STUDY PROGRAMME

3.1 Name of the study programme

Graduate university study programme in Automotive Computing and Communications

3.2 Provider of the study programme

Josip Juraj Strossmayer University of Osijek, Faculty of Electrical Engineering, Computer Science and Information Technology Osijek

3.3 Type of the study programme
University study programme

3.4 Level (1-professional programme /2-specialist graduate professional programme or 1-undergraduate university programme /2-graduate university programme /3-postgraduate specialist or postgraduate university programme
2- graduate university programme

3.5 Scientific or artistic area
Technical Sciences

3.6 Scientific or artistic field
Electrical Engineering, Computer Engineering

3.7 Scientific or artistic branch

2.03.01 Power Engineering
2.03.02 Electromechanical Engineering
2.03.03 Electronics
2.03.04 Telecommunications and Informatics
2.03.05 Radiocommunications
2.03.06 Automation and Robotics

2.09.01 Computer Systems Architecture
2.09.02 Information Systems
2.09.03 Data Processing
2.09.04 Artificial Intelligence
2.09.05 Process Computing
2.09.06 Software Engineering

3.8 Admission requirements

Students can enrol in the study programme pursuant to a vacancy announcement.

The graduate university study programme in Automotive Computing and Communications can be enrolled into by students who graduated from the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and are awarded the following titles:
- University Bachelors of Computer Engineering;
- University Bachelors of Electrical Engineering;

- Bachelors who passed all differential exams at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek thus meeting the requirements for enrolling in the graduate university study programme in Computer Engineering or in the graduate university study programme in Electrical Engineering.

The graduate university study programme in Automotive Computing and Communications can also be enrolled into by:

- University Bachelors of Computer Engineering or Electrical Engineering who graduated from other higher education institutions;
- University Bachelors with a specialisation in Technical or Natural Sciences.

In such cases, the Academic and Student Affairs Committee will determine differential exams to be passed.

3.9 Duration of study

The graduate university study programme lasts for two years (four semesters). A student has to obtain 120 ECTS credits.

3.10 Academic/expert title awarded upon completion of the study programme

Upon completion of the graduate university study programme in Automotive Computing and Communications, students are awarded an academic title of Master of Automotive Computing and Communications.

3.16 List the competencies students acquire and activities they can perform upon completion of the study programme

Graduates holding a Master's degree in Automotive Computing and Communications from the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek have been trained to carry out the following activities in the field of automotive computing and other related areas:

- designing, developing and implementing computer system software solutions;
- designing software solutions;
- working in companies involved in developing circuit and software solutions for autonomous and networked vehicles;
- working in companies involved in developing circuit and software solutions for electric vehicles;
- organising, running, and working in a computer support team;
- conducting laboratory research;
- planning and optimising contemporary hardware and software solutions.

Students also acquire the following additional competencies:

- detecting and correcting dedicated software faults in the software development process;
- analysing and comparing of different simple and complex computer systems;
- acquiring basic knowledge of the working principles, components and the role of electrical machines and drives in the vehicles;

- integrating a developed component into the existing parts of the core and user applications, focusing on Linux device drivers for projects in embedded systems or on traditional PC platforms;
- applying appropriate deep learning methods and models to solving specific problems in intelligent transport systems;
- selecting an embedded system based on application requirements;
- using CAD tools for embedded system design;
- acquiring basic knowledge of power electronics systems for power supply and power management within the vehicle;
- analysing an in-vehicle communication network and defining the characteristics of key in-vehicle communication protocols;
- designing simpler communication systems based on in-vehicle communication protocols;
- acquiring knowledge about the development of secure automotive software support;
- developing the concept of automotive software support: from risk analysis to the concept of functional safety;
- acquiring knowledge of the characteristics of a camera system for autonomous driving;
- developing a prototype of one's own real-time image and video processing algorithm for use in autonomous vehicles;
- designing, planning and testing computer support for the automotive industry;
- applying the basic concepts of automotive diagnostic software;
- implementing and applying various security mechanisms to the vehicle information system model.

3.17 Describe the mechanisms used to ensure vertical mobility of students in national and international higher education space. If focusing on the first level of professional or undergraduate study programmes, list specialist graduate professional study programmes or graduate university study programmes students can enrol in the provider of the study programme or other higher education institutions in the Republic of Croatia

The current configuration of the study programmes (Figure 1) is based on the adjustments of the study programmes carried out prior to the Bologna declaration and similar current study programmes carried out at related European higher education institutions.

The graduate university study programme in Automotive Computing and Communications can be enrolled into by students who graduated from the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and are awarded the following titles:
- University Bachelors of Computer Engineering;
- University Bachelors of Electrical Engineering;
- Bachelors who passed all differential exams at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek thus meeting the requirements for enrolling in the graduate university study programme in Computer Engineering or in the graduate university study programme in Electrical Engineering.

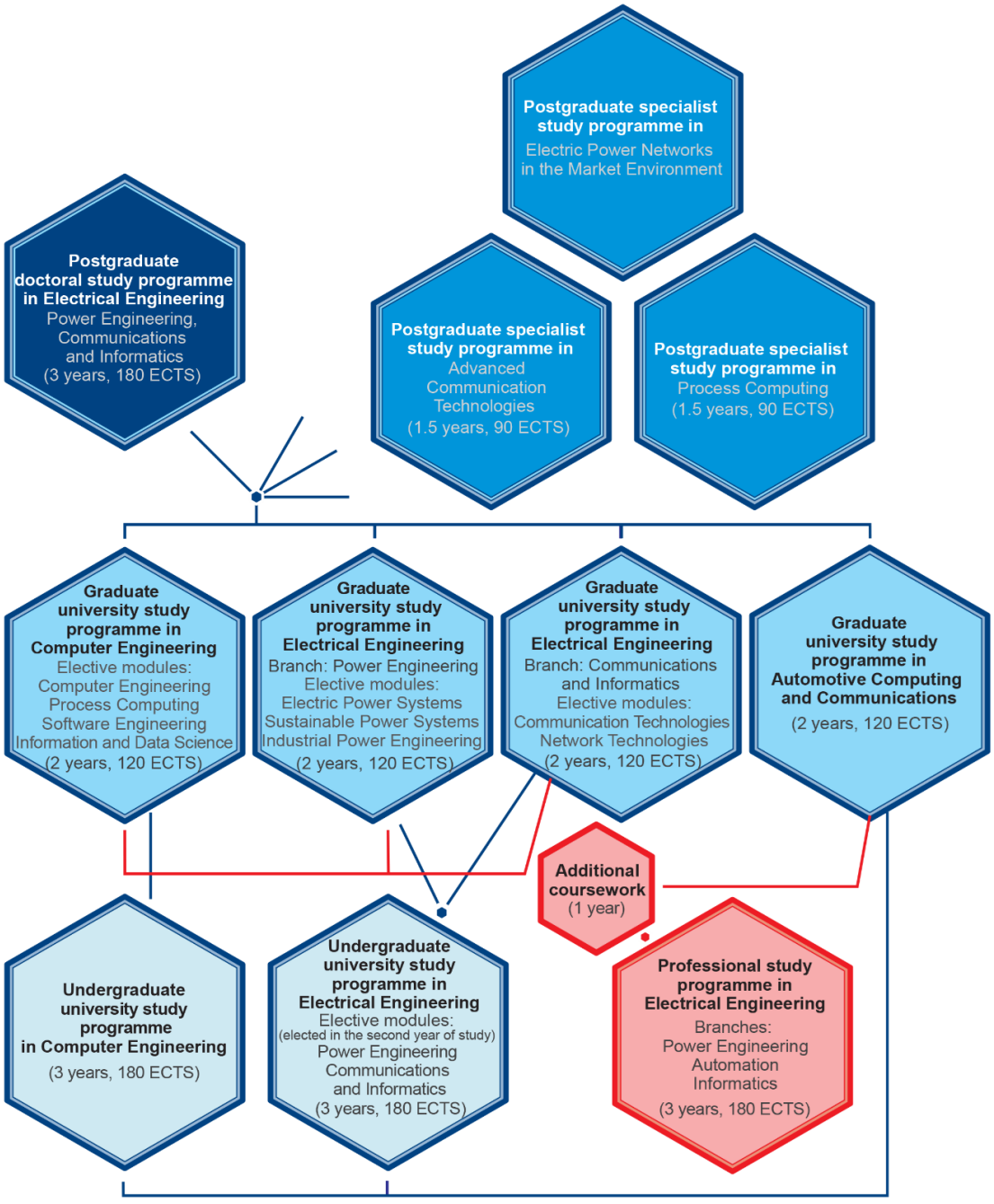

Figure 1. Vertical studying scheme at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek

During the studies, international student mobility is provided by the ERASMUS student mobility programme and the EUROWEB+ scholarship programme, that have been carried out at the University since the academic years 2009/2010 and 2015/2016, respectively (for details, see 3.24). Mobility within the Republic of Croatia is provided by the Student Mobility Agreement concluded on 14 July 2016 by and between the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, Josip Juraj

Strossmayer University of Osijek (FERIT), the Faculty of Electrical Engineering and Computing, University of Zagreb (FER), the Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture in Split (FESB), the Faculty of Mechanical Engineering in Slavonski Brod, Josip Juraj Strossmayer University of Osijek (SFSB), and the Faculty of Engineering, University of Rijeka (RITEH).

3.17.1 Courses students can take and enrol in other University constituent units

Students can choose optional courses offered at Josip Juraj Strossmayer University of Osijek. For example, in the academic year 2016/2017, there were 38 courses offered by 17 University constituent units. However, the ECTS credits earned in this way are not included in the 180 ECTS needed to complete a degree.

3.17.2 List of courses offered in a foreign language

A list of courses offered in a foreign language is provided in Chapter 4.4.

3.17.3 Criteria and conditions for the transfer of ECTS credits

The Faculty organises and carries out the Erasmus International Mobility Programme. The Erasmus International Mobility Programme enables students to spend one part of their studies at a foreign higher education institution or undergo practical training, which significantly contributes to their independence, cultural enrichment, foreign language skills and capability to work in a multicultural environment. Implementation and basic principles of incoming and outgoing student mobility, students' rights and obligations, rights and obligations of the University Committee for the Erasmus International Mobility Programme and the institutional Erasmus coordinator, as well as other questions relevant for the implementation of the mobility programme have been specified in the Regulations on the Erasmus Mobility Programme. On the recommendation of the Erasmus coordinator, the Academic and Student Affairs Committee lays down the criteria and conditions for ECTS recognition for students participating in the Mobility Programme.

3.18 Explain the relationship of the proposed professional/university study programme with fundamental and contemporary skills and field.

The proposed graduate university study programme in Automotive Computing and Communications was designed based on our own recognition of market needs and numerous contacts with companies involved in software and hardware solutions in the automotive industry. Namely, one of the leading European employers - the automotive industry - has focused on in-vehicle hardware and software, i.e. software support and electronics, and embedded systems. As a result, there is a growing demand for engineers with appropriate skills and ICT companies that can meet these requirements. This is precisely the main reason for initiating the graduate university study programme in Automotive Computing and Communications.

The curriculum of the graduate university study programme in Automotive Computing and Communications provides students with the opportunity to specialise in the fields of designing, developing, implementing and testing software support and computer systems in the automotive industry. After gaining basic knowledge in the fields of advanced programming and embedded systems, this graduate university study programme provides students with specific knowledge related to communication networks and in-vehicle protocols, software support design, development and testing in safety-critical control systems (e.g. an autonomous vehicle) and security of vehicle information systems. Additional specific knowledge is gained in this study programme in the fields of vehicle power supply and drive systems, power electronics in automotive

applications, digital image and video processing and the use of machine learning in autonomous and networked vehicles.

3.19 Explain the relationship of the study programme with the needs of a local community (economy, enterprises, civil society, etc.).

A link between the study programme and the needs of the local community is partly shown in 2.4, which describes participation of labour market representatives in the development of higher education institutions. It is also expected that the study programme will meet the needs for new jobs (see 3.20).

Namely, the analysis of labour market data in Croatia shows that experts who complete study programmes related to the proposed one find employment much faster, even in conditions of high unemployment. These fields constitute an important foundation for the development of every society, and the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek is an institution with the longest tradition in education of experts in these fields in Eastern Croatia and the largest numbers of such students, which is then in turn the foundation for future successful education of experts in the fields of automotive computing and communications, but also for retention and recruitment of highly educated staff, as well as economic growth and development, both in the region and in Croatia as a whole.

With regard to numerous companies in Osijek, its surroundings, and Croatia in general, that deal with electrical and computer engineering, as well as the industry, local self-government and civil society, the study programme is closely related to the needs of the labour market. Namely, over the last few years, the presence of electrical and computer engineering in the automotive industry is becoming more significant and the study aims to respond to the growing demand for experts of this profile, which should also form the basis for attracting interested companies to Slavonia and Baranja. Conversations with companies, students, and graduates have implied great interest in launching such study programme in computer engineering.

The graduate university study programme in Automotive Computing and Communications is a contemporary study which responds to the challenges imposed by the development of the modern Croatian society. A study of this kind will provide students with competences which will make them competitive on the labour market. The curriculum is harmonised with demands and competences required by the local community. All skill students will acquire are related to strategic areas important for community sustainability. The study programme meets the challenge of rapid development of new technologies and their applications in automotive industry, as well as demand for new skills, human potential development aimed at employment and economic growth.

The proposed study programme creates a logical unit and rounds up the education of experts in this field. Students completing this study will be capable of dealing with complex problems of applying new technologies in the automotive industry and engineering.

3.21 Compare the proposed professional/university study programme with foreign accredited study programmes in respected higher education institutions especially in the European Union

A detailed comparison with international accredited study programmes at renown higher education institutions in the European Union is given below (see Chapter 2.0):

- Automotive Systems - HAN University of Applied Sciences (https://www.han.nl/opleidingen/master/en/automotive-systems/). The learning outcomes of the proposed study programme highly correspond to the learning outcomes of the following courses: Vehicle Electronics, Control Systems Engineering, Automotive Management, Alternative Powertrains, Intelligent Vehicle Highway Systems
- Automotive Engineering - Universitat Politècnica de Catalunya (https://automocio.masters.upc.edu/en/general-information). The learning outcomes of the proposed study programme highly correspond to the learning outcomes of the following courses: Electric Systems in the Automobile, Automobile Electronics, Electric Vehicle Configuration, Hybrid Vehicles, Introduction to Energy Storage Systems
- Automotive Engineering – double degree programme jointly offered by the following universities (http://www.emae.eu/study-program): Czech Technical University in Prague, TU Chemnitz, IT Bandung, HAN University of Applied Sciences, ENSTA Bretagne. The learning outcomes of the proposed study programme highly correspond to the learning outcomes of the following courses: Microelectronics in Vehicles, Quality, Software Platforms for Automotive Systems, Fahrzeugenergietechnik, Prozessorientiertes Qualitätsmanagement, Hybrid Powertrains, Vehicle Electronics, Alternative Powertrains, Energieelektronik, Theorie elektrischer Maschinen, Projektmanagement
- Automotive Electronics - Technical University of Ostrava (https://www.vsb.cz/en/ects/course-units/usp/?branchId=557#). The learning outcomes of the proposed study programme highly correspond to the learning outcomes of the following courses: Switching Semiconductor Technique, Programming in C/C++, Signal Processing, Microcomputer Control Systems, Automotive Electronics II, Control Electronics of Power Converters
- Automotive Systems - Esslingen University of Applied Sciences (https://www.hs-esslingen.de/en/the-university/faculties/graduate-school/masters-programs/meng-in-automotive-systems.html). The learning outcomes of the proposed study programme highly correspond to the learning outcomes of the following courses: Electric and Electronics Architecture, Automotive Communications, Reliable Embedded Systems
- Automotive Electronics - TH Deggendorf (https://www.th-deg.de/de/et-mt/studiengaenge/ae-m). The learning outcomes of the proposed study programme highly correspond to the learning outcomes of the following modules: Systembetrachtung Fahrzeug, Technologie, System Lifecycle Management, Funktions- und Software-Entwicklungsmethoden, Aktuelle und zukünftige Kommunikationsarchitektur, Elektromobilität und innovative Ansätze

The high level of correspondence of the proposed study programme in Computer Engineering with the considered study programmes ensures exchange and flow of computer engineering students and teachers between J.J. Strossmayer University of Osijek and other European Universities.

3.22 Describe the providers' experience in carrying out the same or similar professional/university study programmes

The graduate university study programme in Computer Engineering has been carried out since academic year 2008/2009 as a continuation of the undergraduate university study programme in Computer Engineering which has been carried out since academic year 2005/2006. Furthermore, the undergraduate

professional study programme in Electrical Engineering, branches: Automation, Power Engineering and Informatics, has also been carried out since academic year 2005/2006.

During the thirty-eight years of the Faculty's existence, over 4000 students have earned their degrees:

- pre-Bologna professional study programme in Electrical Engineering: 1065
- pre-Bologna university study programme in Electrical Engineering: 949
- undergraduate university study programme in Electrical Engineering: 760
- undergraduate university study programme in Computer Engineering: 567
- undergraduate professional study programme in Electrical Engineering: 567
- graduate university study programme in Electrical Engineering: 586
- graduate university study programme in Computer Engineering: 350
- postgraduate doctoral study programme in Electrical Engineering: 58

3.23 If applicable, list partners, other than higher education institutions (economy, public sector, etc.), who would participate in carrying out the proposed study programme

The proposed study programme is based upon a better connection with the economy and it follows the latest technology developments. Companies dealing with automotive computing and communications would participate in the proposed study programme through implementation of practical training and writing of Master's theses.

As stated in Chapter 2.4, on 1st May 2016, the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek launched a special web-portal called "Stup" for our students and employers (stup.etfos.hr). Companies can use "Stup" to inform students about job vacancies, open internships, opportunities to write their final papers and Master's theses and all other activities that are of interest to our students.

Currently, there are over 200 companies using "Stup", and a number of companies are involved in automotive computing and communications (among others RT-RK Osijek, Rimac Automobili, Yazaki, GlobalLogic, Xylon, AVL-AST, etc.), which we consider partners in carrying out the study since they have offered over 200 internships as well as dozens of final paper and Master's thesis topics and other activities which are of interest to our students.

4 STUDY PROGRAMME DESCRIPTION

4.1 Attach a list of obligatory and elective courses with corresponding workload and ECTS credits
See Appendix 7.4.

4.1.1 Attach a description of each course
See Appendix 7.5.

4.1.2 General data on the course
See Appendix 7.5.

4.1.3 Course description

See Appendix 7.5.

4.2 Describe the study structure, pace and requirements for enrolment in the following semester or trimester as well as the requirements for each course or a group of courses

The graduate university study programme in Automotive Computing and Communications is a semester-based study, which consists of four semesters, i.e. two years of study.

In Semester 4, students have the opportunity to choose one elective course, while in Semester 3 students are obliged to undergo practical training which lasts for five weeks. If an exam consists of a written and oral part, the student may be denied the right to take the oral exam in case he/she has not passed the written part. The study is completed when the student writes and defends his/her Master's thesis.

Out of the total of 120 ECTS credits, students earn 90 ECTS and 5 ECTS by passing 16 obligatory and one elective course, respectively. Furthermore, practical training carries 9 ECTS while the Master's thesis carries 16 ECTS.

According to the University Regulations on Studies and Studying, students advance through the study when they enrol in the successive year in accordance with the conditions laid down every year by the University Senate.

4.2.1 Beginning and end of classes

The beginning and end of each academic year is defined by the University Senate's Decision on the Academic Calendar which is an integral part of the curriculum.

4.2.2 Requirements for enrolment in the successive academic year

The requirements for enrolment in the successive academic year has been determined by the Regulations on Studies and Studying of J.J. Strossmayer University of Osijek as well as the University Senate's Decision on Requirements for Enrolment in the Successive Year, and they refer to the following:

- regular fulfilment of obligations determined in the study programme
- the number of ECTS credits earned by passing the exams.

4.2.3 General and specific terms and conditions of studying

Students are subject to general and specific terms and conditions of studying defined by the Statute and Regulations on Studying and Studies of J.J. Strossmayer University of Osijek and they refer to the following:

- acquiring student status (full-time students, guest students, special student status: categorised athletes and top artists, exceptionally successful students)
- transferring from other related university study programmes
- resuming interrupted studies
- mobility within the University
- students' right and obligations (e.g. right to a leave of absence)
- student workload (ECTS)
- advancement during the study (enrolment in the successive year, cancelling the enrolled course, repeating a year of study, semester validation and teacher's signature, examinations and other types of assessment, grade complaints, recognition of exams passed at other universities)

- termination of student status.

4.2.4 Student status

The graduate university study programme in Automotive Computing and Communications can be enrolled as a full-time or part-time study.

4.3 Attach a list of courses students can enrol in other study programmes

See Chapter 3.17.1.

4.4 Attach a list of courses which can be taught in a foreign language

All courses can be taught in the English language with the exception of the course "German Language" (optional), which is only taught in German.

4.5 Describe the completion of the course of study

A student completes the graduate university study programme in Automotive Computing and Communications by passing all the exams, preparing and defending a Master's thesis as defined in Faculty's Regulations on Final Papers and Master's Theses.

4.6 List the requirements for resuming interrupted studies

Students who have interrupted their studies or have lost their student status may continue their studies under conditions defined by the Statute, i.e. the Regulations on Studies and Studying of J.J. Strossmayer University of Osijek.

5 REQUIREMENTS FOR CARRYING OUT THE STUDY PROGRAMME

5.1 Locations for carrying out the study programme

The Faculty of Electrical Engineering, J. J. Strossmayer University of Osijek has 8 000 m^2 at its disposal on three different locations, providing sufficient space for all types of curricular and extracurricular activities. The Faculty's facilities are located on the following addresses:

- Kneza Trpimira 2b (5140 m^2)
- Cara Hadrijana 10b (3260 m^2)
- Cara Hadrijana bb (barracks – building no. 14) (265 m^2).

7. APPENDICES

7.4. List of compulsory and elective courses with the number of hours of active teaching required for their performance and the number of ECTS credits

Table 1.

TEACHERS AND ASSOCIATES

1. YEAR OF STUDY PROGRAM

1. semester

Code	Course	L workload	E workload	ECTS	Teacher
DAR1-01	Computer System Design	45	30	7	Prof.dr.sc. HOCENSKI ŽELJKO
DA1-03	Embedded Linux	30	30	6	Izv. prof. dr. sc. HERCEG MARIJAN Doc.dr.sc. GRBIĆ RATKO
DAK1-03	Advanced Programming	30	30	5	Izv. prof. dr. sc. HERCEG MARIJAN Doc.dr.sc. JOB JOSIP
DA1-02	Automotive Software Quality Assurance	30	30	6	Doc.dr.sc. BLAŽEVIĆ DAMIR
DA1-01	Drive Systems and Vehicle Power Supply	45	15	6	Izv.prof.dr.sc. PELIN DENIS Izv.prof.dr.sc. HEDERIĆ ŽELJKO

2. semester

Code	Course	L workload	E workload	ECTS	Teacher
DA2-02	Software Architecture in Safety-Critical Control Systems	30	30	7	Doc.dr.sc. KRPIĆ ZDRAVKO
DAKb2-04	Object Based Programming	30	30	5	Doc.dr.sc. NYARKO EMMANUEL-KARLO Doc.dr.sc. FILKO DAMIR
DAEbc2-04	Applied Power Electronics	45	15	5	Izv.prof.dr.sc. HEDERIĆ ŽELJKO Izv.prof.dr.sc. PELIN DENIS
DA2-01	Automotive Computer Networks and Protocols	30	45	7	Prof.dr.sc. ŽAGAR DRAGO
DARab2-04-17	Embedded Computer Systems	30	30	6	Doc.dr.sc. KESER TOMISLAV

2. YEAR OF STUDY PROGRAM

3. semester

Code	Course	L workload	E workload	ECTS	Teacher
DA3-02	Digital Image and Video Processing for Autonomous Vehicles	30	30	5	Prof.dr.sc. RIMAC-DRLJE SNJEŽANA Doc.dr.sc. VRANJEŠ MARIO
DA3-04	Methods and Techniques for Automotive Software Testing	30	30	5	Prof.dr.sc. HOCENSKI ŽELJKO
DA3-05	Security of Information Systems	30	30	5	Doc.dr.sc. GRGIĆ KREŠIMIR
DA3-03	Machine Learning in Systems of Autonomous Networked Vehicles	30	30	5	Doc.dr.sc. VRANJEŠ MARIO Doc.dr.sc. GRBIĆ RATKO
DA3-01	Practical Training	0	200	9	Doc.dr.sc. KESER TOMISLAV

4. semester

Code	Course	L workload	E workload	ECTS	Teacher
DAKR4I-01	Digital Image Processing - elective	30	45	5	Prof.dr.sc. RIMAC-DRLJE SNJEŽANA
D4-03	Diploma Paper	0	0	16	
DA4R4I-10	Intelligent Transportation Systems	30	30	5	Doc.dr.sc. BALEN JOSIP
D4F-01	German - facultative	30	30	4	FERČEC IVANKA
DA4-01	Project Management	30	15	4	Izv.prof.dr.sc. CRNJAC-MILIĆ DOMINIKA
DA4I-01	Radar and LiDar in Autonomous Vehicles - elective	30	30	5	Izv. prof.dr.sc. RUPČIĆ SLAVKO Prof.dr.sc. CUPEC ROBERT

7.5. Description and general information of each subject

Table 2.

General information		
Lecturer	Doc.dr.sc. KRPIĆ ZDRAVKO	
Course name	DA2-02 Software Architecture in Safety-Critical Control Systems	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Workload (L+(AE+LE+CE)+S)	30+(0+15+15)+0

1. Course description	
1.1. Goals	
Provide participants with insights into the concepts and architecture of safety-critical control systems software, explain the basics of AUTOSAR: concepts, architecture, methodology, building elements and ways of migration. AUTOSAR - provide students with practical considerations: operating systems, software components, communication, input/output handling, handling of states, system services and memory, diagnostics. Introduce students to the basics of safe automotive software development, with an emphasis on ISO 26262 and basic requirements	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.summarise the basics of AUTOSAR: concepts, architecture, methodology 2.categorise and interpret the elements of AUTOSAR and explain their functions 3.explain ways of handling inputs / outputs, handling states, services, and system memory 4.identify the basics of safe automotive software development, with an emphasis on ISO 26262 and basic requirements 5.develop the concept of automotive software development: from risk analysis to a functionally safe concept 6.propose the design of a technically safe automotive software, and the ways to develop it	
1.4. Course content	
The basics of AUTOSAR: concepts, architecture, methodology, building elements (RTE-Runtime Environment, BSW-Basic Program Support, SWC-Programming Support Components, VFB-Virtual Functional Bus), migration modes. AUTOSAR-practical considerations: operating systems, software components, communication, handling input/output, handling states, system services and memory, diagnostics. Basics of safe automotive software development, with an emphasis on ISO 26262 and basic requirements (safety management, concept development, system development).	
1.5. Teaching methods	Lecture Laboratory exercises Construction exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	

1.8. Course assessment

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises, Design exercises	1.5	1,2,3,5	Lectures, Laboratory exercises, Design exercises	Attendance register. Mandatory attendance percentage is: 70%.	0	10
Writing pre-lab write-ups, results analysis and writing laboratory reports	2	1,2,3,5,6	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	8	20
Oral exam	2	1,2,3,4,5,6	Oral exam	Assessment of student's answers	25	50
Problem-solving related to design exercises	1.5	2,3,4,5,6	Design exercises	Evaluation of problem solving exercises	6	20

1.10. Obligatory literature

1. Staron, Miroslaw: Automotive Software Architectures, An Introduction, Springer International Publishing, 2017.
2. Oliver Scheid, Autosar Compendium - Part 1: Application & RTE, CreateSpace Independent Publishing Platform, 2015.

1.11. Recommended additional literature

1. Thorsten Langenhan, Basic Guide to (Automotive) Functional Safety, epubli GmbH, 2015.
2. Kevin Roebuck, AUTOSAR - AUTomotive Open System ARchitecture: High-impact Strategies - What You Need to Know: Definitions, Adoptions, Impact, Benefits, Maturity, Vendors, Lightning Source, 2011.
3. Steffen Herrmann, Dirk Duerholz, Ralf Staerk, Stefan Kriso, SAFETY Essentials: ISO 26262 at a glance (E/E Engineering Essentials), Kugler Maag Cie, 2015.
4. Wayne Santana, The ISO 26262 Handbook - Everything You Need To Know About ISO 26262, Emereo Publishing, B S I Standards, 2016.
5. British Standards Institute Staff, Road Vehicles. Functional Safety. Guideline on ISO 26262, 2012.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Prof.dr.sc. RIMAC-DRLJE SNJEŽANA, Doc.dr.sc. VRANJEŠ MARIO	
Course name	DA3-02 Digital Image and Video Processing for Autonomous Vehicles	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Workload (L+(AE+LE+CE)+S)	30+(0+15+15)+0

1. Course description	
1.1. Goals	
Introduce students to ADAS systems' features. Introduce students to features of digital images and video signals as well as with the camera system in vehicles. Enable students to apply and develop advanced algorithms for processing of digital images and video signals, with an emphasis on algorithms for usage in autonomous vehicles.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.evaluate different ADAS systems 2.compare image and video processing algorithms for autonomous vehicles 3.apply advanced image and video processing algorithms in real time 4.evaluate the camera systems for autonomous driving 5.apply processing algorithms on images acquired by the camera mirror replacement system 6.develop a prototype of a custom real-time image and video processing algorithm for application in autonomous vehicles	
1.4. Course content	
Introduction to ADAS (Advanced Driver Assistance Systems). Characteristics of digital image and video. Advanced algorithms for real-time and video processing used in autonomous vehicles. Image processing: compression processes, image enhancement methods, edge detection, object detection, classification and recognition, scene segmentation, optical character recognition. Video – video standards, 3D scene reconstruction, time tracking of objects, stereovision, pedestrians detection using cameras. Camera systems in vehicles. Camera mirror replacement.	
1.5. Teaching methods	Lecture Laboratory exercises Construction exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	
1.8. Course assessment	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises, Design exercises	1.4	1,2,4	Lectures, Laboratory exercises, Design exercises	Attendance register. Mandatory attendance percentage is: 70%.	0	10
Writing pre-lab write-ups, results analysis and writing laboratory reports	1.5	2,3,5	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	8	20
Oral exam	1.1	1,2,3,4,5	Oral exam	Assessment of student's answers	25	50
Problem-solving related to design exercises	1	2,3,5,6	Design exercises	Evaluation of problem solving exercises	6	20

1.10. Obligatory literature

1. H. Winner, S.Hakuli, F. Lotz, C.Singer, Handbook of Driver Assistance Systems, Springer 2016.
2. A. Terzis, Handbook of Camera Monitor Systems The Automotive Mirror-Replacement Technology based on ISO 16505; Springer 2016.

1.11. Recommended additional literature

1. J. Ohm, Multimedia Signal Coding and Transmission (Signals and Communication technology), Berlin Heidelberg, Springer, 2015.
2. R. C. G. Gonzalez; R. E Woods, Digital Image Processing. New Jersey: Pearson Education, 2008.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Prof.dr.sc. RIMAC-DRLJE SNJEŽANA	
Course name	DAKR4I-01 Digital Image Processing	
Study program	Graduate study programme, branch: Automotive Computing and Communications (elective)	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Workload (L+(AE+LE+CE)+S)	30+(0+30+15)+0

1. Course description	
1.1. Goals	
Introduce students to analogue and digital television systems and applications of video coding standards in digital television. Enable students to independently develop digital TV software, including the use of a television receiver circuitry, development of middle layer software, use of digital television protocols, and download and use of data from transport stream as well as the design of the basic television application.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the second year of the study programme	
1.3. Learning outcomes	
1.describe the characteristics of video signals; choose the parameters for digitizing and compressing video signals and evaluating its quality 2.analyse the application of DCT, motion estimation and compensation as well as evaluate the application of different video coding standards 3.distinguish source and channel coding methods as well as types of modulation for DVB-T and DVB-T2 4.compare different methods of content protection as well as conditional access in a digital television 5.develop software support for a digital television receiver, including protocol usage, as well as download and use of data from the transport stream 6.design basic TV applications	
1.4. Course content	
Analogue television systems. Component and composite video signal digitization. Time and space correlation. Motion estimation and compensation, calculation of motion vectors. Texture encoding. Entropy coding. Application of MPEG-2, H.264 / AVC and H.265 standards in digital television. Video quality evaluation. Overview of standards for digital television. DVB-T: source and channel encoding, modulation, single-frequency network. Organization of program and transport streams. MPEG-2 transport stream, signaling information, and organization of the audio, video, and data stream delivery to the receiver. Architecture of DTV receiver hardware and software. Content protection, conditional access to content through DVB-CSA, DVB-CI and CI + standards. Architecture of hardware and software support of a conditional access system.	
1.5. Teaching methods	Lecture Laboratory exercises Construction exercises
1.6. Comments	
1.7. Student obligations	

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.8. Course assessment

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises, Design exercises	1.8	1,2,3,4,5,6	Lectures, Laboratory exercises, Design exercises	Attendance register. Mandatory attendance percentage is: 70%.	3	5
Writing pre-lab write-ups, results analysis and writing laboratory reports	0.4	5,6	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	4	10
Oral exam	1.4	1,2,3,4,5	Oral exam	Assessment of student's answers	20	40
Problem-solving related to design exercises	0.9	5,6	Design exercises	Evaluation of problem solving exercises	15	30
Preparation of documentation for the project assignment	0.5	5,6	Construction exercises	Document quality verification	10	15

1.10. Obligatory literature

1. Međunarodne preporuke za digitalnu televiziju: www.etsi.org/standards, www.dvb.org/standards

1.11. Recommended additional literature

1. Walter Fischer: Digital Video and Audio Broadcasting Technology , A Practical Engineering Guide, Third Edition, Springer, 2010.
2. Harve Benoit: Digital Television-Satellite, cable, Terrestial, IPTV, Mobile TV in teh DVB Framework, Focal Press (Elsevier), 2008.
3. E.G. Richardson: H.264 and MPEG-4 video compression, John Wiley & Sons, 2003.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer		
Course name	D4-03 Diploma Paper	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	16
	Workload (L+(AE+LE+CE)+S)	-

1. Course description

1.1. Goals

Define the subject and task of graduate thesis work at the appropriate scientific and professional level, so that the student needs to demonstrate the ability of the engineering work to solve problems based on concrete practical problems (measurements, calculations and design of hardware/sofware, etc.). By guiding the mentor helps the student to solve the task.

1.2. Conditions for enrollment

Requirements met for enrolling in the second year of the study programme

1.3. Learning outcomes

Depends on the topic of the thesis.

1.4. Course content

Depends on the topic of the thesis.

1.5. Teaching methods	Consultations
1.6. Comments	

1.7. Student obligations

Defined by the Regulations on final and master thesis, and paragraph 1.9

1.8. Course assessment

Defined by the Regulations on final and master thesis, and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	**ECTS**	**Learning outcomes**	**Teaching method**	**Assessment method**	**Points**	
					Min	**max**
Defined by Criteria for evaulation of final and diploma papers	-	-	-	-	-	-

1.10. Obligatory literature
Depends on the topic of the thesis.
1.11. Recommended additional literature
Depends on the topic of the thesis.
1.12. Monitoring of students
According to the Regulations on final and master thesis: - the theme is approved by the Committee for final and master thesis. - oral defence of work is carried out in front of Comission for defence

General information		
Lecturer	Prof.dr.sc. HOCENSKI ŽELJKO	
Course name	DAR1-01 Computer System Design	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Workload (L+(AE+LE+CE)+S)	45+(0+30+0)+0

1. Course description	
1.1. Goals	
Introduce students to theoretical and practical knowledge in the field of computer, microprocessor and microprocessor systems design. Students learn to recognise the specific problems of microprocessor, micro-controller and computer design. Furthermore, students acquire skills in applying tools to hardware and software design, simulation of work and design verification. Introduce tools and instruments to develop and diagnose computer performance as a digital oscilloscope, logic analyser, FPGA integrated circuit programmer, software packages for designing digital integrated circuits (such as MicroSIM, OrCAD, Cadence and others).	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.specify and design simple processor systems with peripheral units 2.explain and compare parts of a computer system 3.compare and test the operating mode of various simple and complex computer systems 4.specify and design simple processor systems with peripheral units 5.apply and test simple processor systems on development boards 6.explain and categorise developed and applied processor systems	
1.4. Course content	
Computer architecture and organisation. Microprocessor. 8-bit microprocessor architecture. Intel microprocessor family. State diagram and usage in design. Instruction set. Addressing modes. Instruction formats. Microinstructions and register transfer languages (RTL). Hardware description languages (VHDL). Microprocessor design. Simple CPU design. Single bus microprocessor design. Two and three buses design. Design verification. Microprocessor control unit design. Microsequencer. Microinstructions and nanoinstructions. Computer arithmetic. Fixed point arithmetic. Floating-point arithmetic. Memory system organisation. Cache memory. Virtual memory. Input/output unit organisation. Programmed input/output. Interrupt system. Direct memory access. Input/output processors. RISC architecture. Instruction set. Pipelining. CISC architecture. Parallel processing. Parallelism in uniprocessor system. Multiprocessor architecture. Communication in multiprocessor system. Memory hierarchy. Operating system. Alternative parallel architectures.	
1.5. Teaching methods	Lecture Laboratory exercises
1.6. Comments	
1.7. Student obligations	

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.8. Course assessment

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises	2.5	1,2,3	Lectures, Laboratory exercises	Attendance register. Mandatory attendance percentage is: 60%.	1	2
Writing pre-lab write-ups, results analysis and writing laboratory reports	0.6	2,3,4,5,6	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	4	18
Oral exam	0.5	1,2,3	Oral exam	Assessment of student's answers	15	30
Solving Tasks 1	0.7	1,2,3,4	Revision exam (1/2 of the written exam)	Evaluation of exercises	12	25
Solving Tasks 2	0.7	1,2,3,4	Revision exam (1/2 of the written exam)	Checking solutions	12	25

1.10. Obligatory literature

1. J.D.Carpinelli, Computer Systems Organization & Architecture, Addison Wesley, 2001.

1.11. Recommended additional literature

1. D.Sima, T. Fountain, P.Kacsuk, Advanced Computer Architectures - A Design Space Aproach, Addison Wesley, 1997.
2. B.B. Brey, The Intel Microprocessors 8086-8088, 80186-80188, 80286, 80386, 80486, Pentium Pro Processor and Pentium II, Architecture, Programming and Interfacing, Prentice Hall, 2000.
3. K. Hwang, D. DeGroot: Parallel Processing for Supercomputers and Artificial Intelligence, McGraw-Hill, New York, 1989.
4. Volnei A. Pedroni, Circuit Design and Simulation with VHDL, Second Edition, London, 2010
5. David Harris, Sarah Harris, Digital Design and Computer Architecture, Second Edition, 2012
6. David A. Patterson and John L. Hennessy, Computer Organization and Design, Fifth Edition: The Hardware/Software Interface, 2013
7. William Stallings, Computer Organization and Architecture (9th Edition), 2012
8. Mario Kovač, Arhitektura računala, 2015
9. V.P.Heuring, H.F.Jordan, Computer Systems Design and Architecture, Addison Wesley, 1997.
10. S.Ribarić, RISC i CISC arhitektura, Školska knjiga, Zagreb, 1994.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Doc.dr.sc. BALEN JOSIP	
Course name	DA4R4I-10 Intelligent Transportation Systems	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Workload (L+(AE+LE+CE)+S)	30+(0+30+0)+0

1. Course description	
1.1. Goals	
Introduce students to the field of intelligent transport systems with an emphasis on VANETs (Vehicular Ad-hoc Networks). Teach and train students to develop, implement and evaluate algorithms for efficient information dissemination among vehicles and infrastructure in VANETs.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the second year of the study programme	
1.3. Learning outcomes	
1.identify basic principles and challenges in Intelligent Transport Systems 2.explain the benefits of new technologies embedded in vehicles and transportation infrastructure 3.analyse, compare and evaluate various information dissemination approaches in VANETs 4.develop and implement algorithms for message dissemination in VANETs 5.conduct algorithm test by using traffic and network simulators 6.collect measurement results and evaluate the performance	
1.4. Course content	
Introduction to basic principles and challenges in intelligent transport systems. Intelligent roads and traffic infrastructure. Overview of new technologies built into vehicles (architecture, embedded systems, operating systems, communication devices). Autonomous driverless vehicles. Information dissemination in VANETs (applications, concepts). Safety of communication, vehicles and pedestrians. Algorithms and protocols for efficient information dissemination among vehicles. Simulation of traffic and communication between vehicles and infrastructure using Omnet ++, Veins and SUMO simulators. Processing obtained results and performance evaluation.	
1.5. Teaching methods	Lecture Laboratory exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	
1.8. Course assessment	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises	0.8	1,2,3,4,5,6	Lectures, Laboratory exercises	Attendance register. Mandatory attendance percentage is: 70%.	4	10
Writing pre-lab write-ups, results analysis and writing laboratory reports	1	5,6	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	0	25
Oral exam	1	1,2,3,4	Oral exam	Assessment of student's answers	18	35
Solving a project task	2.2	1,2,3,4,5,6	Team work and programming solution development	Questions based on a presented project assignment	20	30

1.10. Obligatory literature

1. Sommer, C; Dressler, F. Vehicular Networking. Cambridge University Press, 2014.
2. Bošnjak, I. INTELIGENTNI TRANSPORTNI SUSTAVI - ITS 1. Zagreb: Fakultet prometnih znanosti, Sveučilište u Zagrebu, 2006.

1.11. Recommended additional literature

1. S. Ghosh, T. S. Lee, Intelligent Transportation Systems: Smart and Green Infrastructure Design, Second Edition, CRC Press, 2010
2. R. Popescu-Zeletin, I. Radusch, M. Rigani: Vehicular-2-X Communication: State-of-the-Art and Research in Mobile Vehicular Ad hoc Networks. Springer, 2010
3. 3. M. Picone, S. Busanelli, M. Amoretti, F. Zanichelli, G. Ferrari, Advanced Technologies for Intelligent Transportation Systems, Springer, 2014
4. J. Balen, Učinkovito rasprostiranje poruka u mrežama vozila zasnovano na njihovom položaju, doktorska disertacija, Osijek, Elektrotehnički fakultet, 2014.
5. C. Sommer, F. Dressler, Progressing Toward Realistic Mobility Models in VANET Simulations, IEEE Communications Magazine, vol. 46 (11), pp. 132-137, studeni 2008.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Izv. prof. dr. sc. HERCEG MARIJAN, Doc.dr.sc. GRBIĆ RATKO	
Course name	DA1-03 Embedded Linux	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Workload (L+(AE+LE+CE)+S)	30+(0+15+15)+0

1. Course description	
1.1. Goals	
The aim of the course is to familiarise students with the structure and working principles of the Linux operating system and the adaptation of the Linux kernel to different platforms. Enable students to independently design and develop software components for the Linux kernel, with special emphasis on the use in real-time embedded systems.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.understand the internal structure and operation principles of the Linux operating system 2.understand the principle of memory management and accessing of input-output units 3.customise the Linux kernel for the target platform 4.develop software components for the Linux kernel 5.integrate developed components with existing kernel components and user applications, focusing on Linux device drivers for projects in embedded systems or on traditional PC platforms 6.adopt and understand debugging techniques when developing Linux kernel components	
1.4. Course content	
Introduction to the Linux kernel. Kernel source code. Configuring, compiling and booting of the Linux kernel. Linux kernel modules. Memory management and access to the hardware. Character device drivers. Processes, scheduling, queuing, interrupt handling and locking. Debugging techniques of the Linux kernel. Device driver kernel architecture. Details of Linux kernel booting. Customise the Linux kernel for target platforms. Power management.	
1.5. Teaching methods	Lecture Laboratory exercises Construction exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	
1.8. Course assessment	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises, Design exercises	1.5	1,2,3,4,5,6	Lectures, Laboratory exercises, Design exercises	Attendance register. Mandatory attendance percentage is: 70%.	0	5
Writing pre-lab write-ups, results analysis and writing laboratory reports	1.5	3,4,5,6	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	15	30
Oral exam	1.5	1,2,3,4,5,6	Oral exam	Assessment of student's answers	18	35
Problem-solving related to design exercises	1.5	3,4,5,6	Design exercises	Evaluation of problem solving exercises	15	30

1.10. Obligatory literature

1. Sam Siewert, John Pratt: Real-Time Embedded Components and Systems with Linux and RTOS, Mercury Learning & Information, 2016.
2. Doug Abbott: Linux for Embedded and Real-time Applications, Edition 3, Newnes, 2012.

1.11. Recommended additional literature

1. Karim Yaghmour, Jon Masters, Gilad Ben-Yossef, Philippe Gerum: Building Embedded Linux Systems, O'Reilly Media, 2008.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Prof.dr.sc. HOCENSKI ŽELJKO	
Course name	DA3-04 Methods and Techniques for Automotive Software Testing	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Workload (L+(AE+LE+CE)+S)	30+(0+15+15)+0

1. Course description	
1.1. Goals	
Introduce and explain the concepts and objectives of software testing and diagnostics. Introduce special cases of automotive programme testing. Introduce the automotive ECU testing methods. Explain the basic principles of diagnostics. Introduce students to online/offline equipment calibration.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.explain the concepts and objectives of software testing 2.enumerate and explain special cases of automotive software testing 3.explain and apply the automotive ECU testing methods 4.explain and apply the basic concepts of automotive software diagnostics	
1.4. Course content	
Concepts/objectives of automotive software testing and diagnostics. Special cases of automotive software testing (types, environments, modules, flows, etc.). Methods for testing automotive ECU - SIL&HIL, modelling (XML+HTML, for ODX), simulation/emulation. Diagnostics - details and parameters, data mining. Equipment calibration - online/offline Laboratory exercises: CANape+XCP+Data mining, CANoe+CANalyser+CAPL for FLEXRAY/CAN, additional specific software	
1.5. Teaching methods	Lecture Laboratory exercises Construction exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	
1.8. Course assessment	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	
1.9. Assessment and evaluation of the students' work during the semester and on the final exam	

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises, Design exercises	1.4	1,2,3,4	Lectures, Laboratory exercises, Design exercises	Attendance register. Mandatory attendance percentage is: 70%.	0	10
Writing pre-lab write-ups, results analysis and writing laboratory reports	1.5	2,3,4	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	8	20
Oral exam	1.1	1,2,3,4	Oral exam	Assessment of student's answers	25	50
Problem-solving related to design exercises	1	2,3,4	Design exercises	Evaluation of problem solving exercises	6	20

1.10. Obligatory literature

1. G. D. Everet, R. McLeod jr. Software Testing -Testing accross the Entire Software Development Life Cycle, IEEE Press, Wiley -Interscience, John Wiley&Sons, Inc., 2007

1.11. Recommended additional literature

1. R. Patton, Software Testing, SAMS Publishing, 2005
2. C. Karner, J. Falk, H. Q. Nguyen, Testing Computer Software, John Wiley, 1999.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Izv. prof. dr. sc. HERCEG MARIJAN, Doc.dr.sc. JOB JOSIP	
Course name	DAK1-03 Advanced Programming	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Workload (L+(AE+LE+CE)+S)	30+(0+15+15)+0

1. Course description	
1.1. Goals	
The aim of the course is to enable students to independently and systematically develop a programming application by using available libraries and mechanisms that programming languages, operating systems and hardware offer. The aim is to develop mental concepts in students to enable understanding of the relationship and dependence between programmes and hardware architecture.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.identify the special features of compilers for a targeted architecture when designing programming applications 2.explain the programming code compilation process 3.assess the efficiency of the memory usage in a code and suggest possible improvements 4.develop a software solution of the given simple task for targeted architecture 5.define and debug errors in dedicated software support while creating the one 6.evaluate operation of a developed software solution	
1.4. Course content	
Tasks of software and its features. Development, debugging and testing of software. C language elements: the size and representation of the basic data types; variables and their representation within the given architecture; memory assignment mechanisms; functions; indicators; structures, unions and address alignment; code compilation. Version control systems. C programming language extensions, special extensions in some C compilers.	
1.5. Teaching methods	Lecture Laboratory exercises Construction exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	
1.8. Course assessment	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises, Design exercises	1	1,2,3,4,5,6	Lectures, Laboratory exercises, Design exercises	Attendance register. Mandatory attendance percentage is: 70%.	5	10
Writing pre-lab write-ups, results analysis and writing laboratory reports	1	4,5,6	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	10	20
Oral exam	2	1,2,3,4,5,6	Oral exam	Assessment of student's answers	25	50
Problem-solving related to design exercises	1	1,4,5,6	Design exercises	Evaluation of problem solving exercises	10	20

1.10. Obligatory literature

1. Šribar, J; Motik, B. Desmistificirani C++, 3. Dopunjeno izdanje, 2010.
2. Heathfield, Richard; Lawrence, Kirby et al. C Unleashed, SAMS, 2000.

1.11. Recommended additional literature

1. C99 language standard, ISO/IEC 9899:TC3, ISO/IEC, 2007.
2. Richard Heathfield, Lawrence Kirby et al, C Unleashed, SAMS, 2000.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	FERČEC IVANKA	
Course name	D4F-01 German	
Study program	Graduate study programme, branch: Automotive Computing and Communications (facultative)	
Course status	Facultative	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	4
	Workload (L+(AE+LE+CE)+S)	30+(30+0+0)+0

1. Course description	
1.1. Goals	
According to the Common European Framework of Reference for Languages for Level A1 (Basic User – Breakthrough or Beginner), students can understand and use familiar everyday expressions and very basic phrases aimed at the satisfaction of needs of a concrete type, introduce themselves and others, ask and answer questions about personal details (such as where he/she lives, people they know and things they have), interact in a simple way (provided the other person talks slowly and clearly and is prepared to help).	
1.2. Conditions for enrollment	
None	
1.3. Learning outcomes	
1.relate the basic concepts used in everyday private and business environments that are thematically related to the topics discussed in the course (introducing oneself, family, activities, food and drink, traffic, travelling, counting) 2.formulate everyday activities in the private and business environments that are thematically related to the topics discussed in the course, and compare the rules of Croatian and German 3.apply new grammar-related knowledge (e.g. Personalpronomen, Possessivartikel, definiter und indefiniter Artikel, Negativartikel, Zahlen, Verb: Präsens, W-Fragen, Ja/Nein Fragen, Perfekt mit sein und haben, Modalverben können, mögen) 4.write simple and short texts thematically related to the topics discussed in the course	
1.4. Course content	
1. define the basic concepts used in everyday private and business environments that are thematically related to the topics discussed in the course (introducing oneself, family, activities, food and drink, traffic, travelling, counting); 2. describe everyday activities in the private and business environments that are thematically related to the topics discussed in the course, and compare the rules of Croatian and German; 3. apply new grammar-related knowledge (e.g. Personalpronomen, Possessivartikel, definiter und indefiniter Artikel, Negativartikel, Zahlen, Verb: Präsens, W-Fragen, Ja/Nein Fragen, Perfekt mit sein und haben, Modalverben können, mögen); 4. write simple and short texts thematically related to the topics discussed in the course.	
1.5. Teaching methods	Lecture Auditory exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	

1.8. Course assessment

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Auditory exercises	1.4	1,2,3,4	Lectures, Auditory exercises	Attendance register. Mandatory attendance percentage is: 70%.	0	0
Practice – problem solving	1.2	1,2,3,4	Midterm exam	Evaluation of (written) exercises	25	50
Oral exam	1	1,2,3	Oral exam	Assessment of student's answers	20	40
Homework	0.2	1,2,3,4	Grammar-related exercises/Short essays	Evalution of exercises/Correcting exercises and essays	0	5
Self-participation in classes	0.2	1,2,3,4	Self-initiated participation in teaching in the application of processed language and grammatical structures	Evidence of self-participation in classes/ verification of answers given	0	5

1.10. Obligatory literature

1. Evans, S; Pude, A; F. Specht. Menschen (A 1.1) – Kursbuch. Hueber Verlag GmbH&Co KG, Ismaning, 2012..
2. S. Glas-Peters, A. Pude, M. Reimann. Menschen (A 1.1) – Arbeitsbuch. Hueber Verlag GmbH&Co KG, Ismaning, 2012.

1.11. Recommended additional literature

1. S. Schlüter, Menschen (A 1) - Berufstrainer, Hueber Verlag GmbH&Co KG, München, 2015.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Doc.dr.sc. NYARKO EMMANUEL-KARLO, Doc.dr.sc. FILKO DAMIR	
Course name	DAKb2-04 Object Based Programming	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Workload (L+(AE+LE+CE)+S)	30+(0+30+0)+0

1. Course description	
1.1. Goals	
Introduce the basic principles of object-oriented programming to students, introduce students to C # and Python programming languages, show how to design an application with a graphical user interface.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.identify the organisational structure and develop elements for the object model 2.create user-defined data types (classes) and suitable objects 3.develop a programme in an appropriate programming language which, based on object-oriented approach, solves a given problem 4.identify errors in a programme code and correct them, create an executable version of a programme and test it 5.design and create a computer programme that solves a given problem	
1.4. Course content	
Fundamental principles of object-oriented programming, differences compared to procedural programming. Program languages C# and Python. Concept classes and objects. Variables and methods as part of an object. Class properties and their access. Basic procedures for creating and destroying an object. Object lifetime. Polymorphism, list of diverse objects and virtual functions. Inheritance. Accessing class properties: private, protected and public. Operator overloading. Function and class templates. Exception handling. Templates. Threading and multi-threaded applications. Events. Creating applications with a graphical user interface.	
1.5. Teaching methods	Lecture Laboratory exercises
1.6. Comments	Classes can be taught in a foreign language (English)
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	
1.8. Course assessment	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises	2	1,2,3,4,5	Lectures, Laboratory exercises	Attendance register. Mandatory attendance percentage is: 70%.	7	10
Writing pre-lab write-ups, results analysis and writing laboratory reports	1	1,2,3,4,5	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	10	30
Oral exam	1	1,2,3,4,5	Oral exam	Assessment of student's answers	18	35
Project tasks	1	1,2,3,4,5	Solving project tasks	Evaluation of a project assignment, presentation grading	0	25

1.10. Obligatory literature

1. Lutz, M. Learning Python, 5th Edition. O'Reilly Media, 2013.

1.11. Recommended additional literature

1. The Python Tutorial (https://docs.python.org/2/tutorial/)
2. C# Tutorial (http://www.csharp-station.com/tutorial.aspx)
3. L. Jesse: Programming C#, 4th Edition, O'Reilly Media, 2005 prijevod: Programiranje C#; Antić, Ana; Grgić, Marko

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Doc.dr.sc. BLAŽEVIĆ DAMIR	
Course name	DA1-02 Automotive Software Quality Assurance	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Workload (L+(AE+LE+CE)+S)	30+(0+15+15)+0

1. Course description	
1.1. Goals	
Provide students with ways to determine software quality, quality assurance, metrics and lifecycle management. Introduce students to design, implementation, and basic automotive software testing procedures based on automotive industry standards and best practices.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.distinguish and recognise software quality factors 2.develop project documentation for software development 3.evaluate the complexity of a software project and determine the required resources 4.organize, lead, participate in a computer support team for automotive applications 5.plan, design, develop and test software for automotive applications 6.recognise, understand and evaluate the engineering processes and practices used in the automotive software industry and apply them to improve the software development process	
1.4. Course content	
Organisation of a quality assurance programme. Process quality management. Software crisis. Standardisation processes of software quality assurance. The cost of software quality. Static and dynamic analysis applied to quality assurance. Software reliability. Automotive software architecture and design. Software verification and validation in automotive industry. Automotive software management. Automotive software developement and practice.	
1.5. Teaching methods	Lecture Laboratory exercises Construction exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	
1.8. Course assessment	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises, Design exercises	1.4	1,2,3,6	Lectures, Laboratory exercises, Design exercises	Attendance register. Mandatory attendance percentage is: 70%.	0	10
Writing pre-lab write-ups, results analysis and writing laboratory reports	1.5	1,3,4,5,6	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	8	20
Oral exam	1.6	1,2,3,4,5,6	Oral exam	Assessment of student's answers	25	50
Problem-solving related to design exercises	1.5	2,3,4,6	Design exercises	Evaluation of problem solving exercises	6	20

1.10. Obligatory literature

1. A. S. Tanenbaum, Structured Computer Organization, 7th ed., Prentice-Hall, New Jersey, 2005
2. J. Schauffele, Automotive Software Engineering: Principles, Processes, Methods, and Tools, SAE International, 2005.

1.11. Recommended additional literature

1. N. Navet, F. Simonot-Lion (Editors), Automotive Embedded Systems Handbook, CRC Press, 2009.
2. E. Cochlovius, A. Stiegler. Frame-synchronous, distributed video-decoding for in-vehicle infotainment systems. 2011 IEEE International Conference on Consumer Electronics-Berlin (ICCE-Berlin). 2011.
3. E. Cochlovius, D. Dodge, S. Acharya. The Multimedia Engine MME-a Flexible Middleware for Automotive Infotainment Systems. Consumer Electronics, 2008. ICCE 2008. Digest of Technical Papers. International Conference on. IEEE, 2008.
4. R. Pressman, Software engineering, McGraw-Hill, 1987.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Izv.prof.dr.sc. PELIN DENIS, Izv.prof.dr.sc. HEDERIĆ ŽELJKO	
Course name	DA1-01 Drive Systems and Vehicle Power Supply	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Workload (L+(AE+LE+CE)+S)	45+(0+15+0)+0

1. Course description	
1.1. Goals	
Teach students the basics of vehicle dynamics, and the basics of modelling energy and power needs. Present the topology of vehicle drives (classic, electric, hybrid), and introduce students to electric machines for electric vehicle drives (divisions, operating principles, basics). Familiarise students with typical loads power systems and energy storage systems in vehicles. Describe the basic ways of controlling energy flows in the vehicle using power electronic energy converters. Present sensors and actuators in a vehicle. Introduce students to wiring, relay and contactor systems for different voltage levels.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.create vehicle drive models for understanding the basics of dynamics, and perform simulation results analysis 2.analyse basic control techniques for energy flows in a vehicle by applying power electronic converters 3.understand the operating principles, construction parts, and the role of electrical machines in vehicles 4.classify electrical power supply systems and energy storage in vehicles 5.create models of basic energy storage systems in a vehicle and perform a critical analysis of simulation results	
1.4. Course content	
Basics of vehicle dynamics, physics of motion and needs for energy and power. Basic vehicle drive components, topology of drives (classic, electric, hybrid), basic modelling of energy and power flows based on dynamic vehicle parameters at different driving regimes. Basics of electric drive machines, operating principles, parameters and modes of operation, and basics of modelling. Typical vehicles and energy storage systems in a vehicle. Power electronic energy converters for connecting the vehicle's loads and energy storage system. External charging systems for electric vehicles. Battery management systems in electric vehicles. Actuators and sensors in vehicle drives, wiring systems, relays and contactors for different voltage levels.	
1.5. Teaching methods	Lecture Laboratory exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	
1.8. Course assessment	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology	

Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises	1.4	1,2,4	Lectures, Laboratory exercises	Attendance register. Mandatory attendance percentage is: 70%.	0	10
Writing pre-lab write-ups, results analysis and writing laboratory reports	1.5	3	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	20	20
Oral exam	1.1	1,2,4	Oral exam	Assessment of student's answers	20	40
Writing a seminar paper and presentation of the best papers	1.5	3,5	Individuall work	Evaluation of the seminar paper a presentation of the paper	0	20
Team work	0.5	3,5	Team work	Team work evaluation. Evalution of students' answers.	0	10

1.10. Obligatory literature

1. B. Skalicki: Električni strojevi i pogoni , Zagreb FESB 2004
2. I. Flegar: Elektronički energetski pretvarači, Kigen, Zagreb, 2010.
3. Seref Soylu: Electric Vehicles - Modelling and Simulations, open access - InTech, DOI: 10.5772/958

1.11. Recommended additional literature

1. Automotive Sensors & Actuators, Master Study Ramaiah School of Advanced Studies - Bangalore
2. M. Alaküla: Hybrid Drive Systems for Vehicles, Lund University
3. Tallner _Batteries or supercapacitors as energy storage in HEVs1. Lund University
4. Ion Boldea, Syed A. Nasar (2006.), Electric Drives, Prentice Hall
5. A. Emadi: Handbook of Automotive Power Electronics and motor drives, Taylor & Francis Group, LLC, 2005.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	lzv.prof.dr.sc. HEDERIĆ ŽELJKO, lzv.prof.dr.sc. PELIN DENIS	
Course name	DAEbc2-04 Applied Power Electronics	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Workload (L+(AE+LE+CE)+S)	45+(0+15+0)+0

1. Course description	
1.1. Goals	
Teach student's about the topology of power electronic converters (PECs) for connecting renewable energy sources to a power grid and/or loads as well as for vehicle drives. Present the modulation technique of switching with PEC components in terms of optimising the harmonic content of the loads current and/or voltage as well as the voltage harmonic content of a power grid or power supply system in typical applications. Introduce students to hybrid electric vehicles (HEVs). Teach students about the modelling technology for the purpose of carrying out the analysis and synthesis of work, power flows, integration and design of HEV drives. Teach students about modelling and analysing the operation of energy storage systems in electric vehicles.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.classify topologies of power electronic converters when connecting renewable energy systems with a grid and/or loads and for vehicle drives 2.classify modulation control techniques of power electronic converters (PEC) with respect to harmonic content of load current and load voltage 3.analyse the ways of connecting typical renewable energy sources with loads and/or sources 4.create HEV model simulation models, and perform critical analysis of simulation results 5.analyse energy storage systems in electric vehicles	
1.4. Course content	
Distribution of renewable energy sources and their special features when connecting to a power grid and/or loads. Topology of power electronic converters (PECs) for connecting wind turbines, photovoltaic modules (strings) and fuel cells to power grids and/or vehicles and vehicle systems. Modulation techniques for converter conversion PEC components in order to optimise the harmonic power content and/or load voltage as well as the harmonic content of the power supply or a power supply system in the vehicle. Hybrid power generation systems. Hybrid electric vehicles, drive modelling techniques for carrying out the analysis and synthesis of work, power flows, integration and design of drives. HEV subdivision and subsystems. Analysis of the operating mode of the vehicle with respect to a driving mode of the vehicle. Power flows and system losses. Define basic energy storage management systems - batteries, super capacitors and hybrid systems.	
1.5. Teaching methods	Lecture Laboratory exercises
1.6. Comments	
1.7. Student obligations	

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.8. Course assessment

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises	1.4	1,2,4	Lectures, Laboratory exercises	Attendance register. Mandatory attendance percentage is: 70%.	0	10
Writing pre-lab write-ups, results analysis and writing laboratory reports	1	3	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	20	20
Oral exam	1.1	1,2,4	Oral exam	Assessment of student's answers	20	40
Writing a seminar paper and presentation of the best papers	1	3,5	Individuall work	Evaluation of the seminar paper a presentation of the paper	0	20
Team work	0.5	3,5	Team work	Team work evaluation. Evalution of students' answers.	0	10

1.10. Obligatory literature

1. B. Skalicki: Električni strojevi i pogoni , Zagreb FESB 2004
2. I. Flegar: Elektronički energetski pretvarači, Kigen, Zagreb, 2010.

1.11. Recommended additional literature

1. S. Sumathi,L. Ashok Kumar, P. Surekha: Solar PV and Wind Energy Conversion Systems, Springer, 2015.
2. R. Teodorescu, M. Liserre, P. Rodriguez: Grid converters for photovoltaic and wind power systems, John Willey & Sons Ltd, 2011.
3. A. Emadi: Handbook of Automotive Power Electronics and motor drives, Taylor & Francis Group, LLC, 2005.
4. M. Alaküla: Hybrid Drive Systems for Vehicles, Lund University
5. Tallner _Batteries or supercapacitors as energy storage in HEVs1. Lund University

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Izv.prof.dr.sc. CRNJAC-MILIĆ DOMINIKA	
Course name	DA4-01 Project Management	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	4
	Workload (L+(AE+LE+CE)+S)	30+(15+0+0)+0

1. Course description	
1.1. Goals	
Teach students project management as a management process where knowledge, skills, tools and techniques are implemented in project activities to meet project requirements and needs, as well as strategic goals of a business organisation.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.specify and explain basic management functions 2.define and explain enterprise management by projects 3.specify and describe the basic skills needed by managers that are important for quality management 4.explain the strategic dimension of project management 5.explain the operational dimension of project management, analyse project work phases, and develop business plan premises for a particular project 6.analyse the entirety of project tasks, and construct an example of a budget for a specific project	
1.4. Course content	
Projects and project-oriented business (notion, concept and key features of a project, fundamental differentiation of projects, project life cycle). Concept and context of project management. Project management development strategy (project management development phases, project management strategy development). Designing a project management organisation (designing a one-off project management organisation, designing a project management organisation, organising and developing a project management system). Strategic dimension of project management (initiation and activation of project implementation, logistics planning and organisation of project realisation, evaluation and conclusion of project implementation). Operational dimension of project management (project integration management, project organisation management, realisation of primary project objectives, project management control and management project changes, project management development perspectives).	
1.5. Teaching methods	Lecture Auditory exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	
1.8. Course assessment	

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Auditory exercises	1.5	1,2,3,4,5,6	Lectures, Auditory exercises	Attendance register. Mandatory attendance percentage is: 70%.	0	10
Practice – problem solving	0.5	1,2,6	Midterm exam	Evaluation of (written) exercises	15	30
Oral exam	0.5	1,2,5	Oral exam	Assessment of student's answers	15	30
Creation of ppt presentations and presentation of the topic of seminar work	0.5	1,4,6	Students, according to teacher's instructions, make the content of the presentation on the given topic of the seminar work, while simultaneously following the contents of the previously written work. Creating in team.	After examining the topic of seminar work with the help of the ppt presentation, the teacher assigns points for a successfully completed activity	0	15
Seminar paper	1	3,4,6	Studying literature related to the subject of seminar work and writing seminar work. Teamwork.	According to the guidelines for writing seminar work, the content and written expression of the written form of seminar work is evaluated.	0	15

1.10. Obligatory literature

1. Projektni menadžment, Mislav Ante Omazić, Stipe Baljkas, Sinergija, Zagreb, 2005.

1.11. Recommended additional literature

1. PMI vodič kroz znanja o upravljanju projektima-četvrto izdanje, Project Management Institute, MATE d.o.o.,2011.
2. Projektni menadžment, Marin Buble, Minerva-visoka poslovna škola, Dugopolje, 2010.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Izv. prof.dr.sc. RUPČIĆ SLAVKO, Prof.dr.sc. CUPEC ROBERT	
Course name	DA4I-01 Radar and LiDar in Autonomous Vehicles	
Study program	Graduate study programme, branch: Automotive Computing and Communications (elective)	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Workload (L+(AE+LE+CE)+S)	30+(0+15+15)+0

1. Course description	
1.1. Goals	
The goal of the course is to introduce students to the basic priniciples of radar and lidar, as well as to the specifics of their application in autonomous vehicles. Present methods for measuring of distance, speed and angle of objects detected by a radar or lidar as well as the basics of signal processing related to these measurements. Introduce students to the approaches of using lidar for localisation of a vehicle on a map stored in the vehicle control computer memory.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.explain the basic principles of radar and lidar 2.apply radar and lidar in autonomous vehicles 3.explain procedures for measurement of distance, speed and angle of objects detected by radar and lidar 4.identify problems with measuring distance, speed and angle of objects detected by radar and lidar as well as possible solutions 5.define existing technical solutions in radar and lidar domain and trends in their development 6.explain the principle of using lidar for localisation of autonomous vehicles on a map stored in the vehicle control computer memory	
1.4. Course content	
Basic principles of lidar and its application in autonomous vehicles. Distance and speed measurement using lidar. Main parameters of radar systems in autonomous vehicles. Measuring visibility, day/night detection, pollution detection, speed adjustment and object recognition using lidar. Electromagnetic compatibility. Current technology of radar and lidar in vehicles. Processing of 3D point clouds obtained by lidar. Environment perception and vehicle localisation using lidar. Lidar-based mapping.	
1.5. Teaching methods	Lecture Laboratory exercises Construction exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	
1.8. Course assessment	

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises, Design exercises	1.4	1,2,3,4,5,6	Lectures, Laboratory exercises, Design exercises	Attendance register. Mandatory attendance percentage is: 70%.	5	10
Writing pre-lab write-ups, results analysis and writing laboratory reports	1	1,2,3,4,6	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	0	20
Oral exam	1.6	1,2,3,4,5,6	Oral exam	Assessment of student's answers	25	50
Problem-solving related to design exercises	1	2,3	Design exercises	Evaluation of problem solving exercises	10	20

1.10. Obligatory literature

1. H. Winner, S.Hakuli, F.Lotz, C.Singer, Handbook of Driver Assistance Systems, Springer Reference, Switzerland, 2016.

1.11. Recommended additional literature

1. V. Jain, P.Heydari, Automotive Radar Sensors in Silicon Technologies, Springer, New York, London, 2013.
2. V. Issakov, Microwave Circuits for 24 GHz Automotive Radar in Silicon-based Technologies, Springer Verlag, Berlin Heidelberg, 2010.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Prof.dr.sc. ŽAGAR DRAGO	
Course name	DA2-01 Automotive Computer Networks and Protocols	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Workload (L+(AE+LE+CE)+S)	30+(0+30+15)+0

1. Course description	
1.1. Goals	
Introduce students to characteristics and parameters of computer networks and protocols. Teach students the methods and tools for network design and analyses and synthesis of communication protocols. Explain specifics of computer networks and protocols in automotive industry. Teach students the basic serial bus protocols as a basis for advanced study of automotive communication protocols.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.understand and describe characteristics and parameters of computer networks according to application requirements 2.apply the basic methods and tools for formal specification, verification and validation of computer protocols 3.define communication methods among vehicle computer systems and build simple computer programmes for such environments 4.analyse automotive computer network and define the characteristics of key protocols for automotive communication 5.design a simple communication system based on automotive communication protocols	
1.4. Course content	
Communication network architecture. Network hardware., LAN, MAN, WAN, wireless networks. Error control and flow management in a computer network. Congestion control in a computer network. Computer network design. Computer network optimisation. Protocols and protocols architecture. Phases of communication protocol design. Tools for analyses and synthesis of communication protocols. The characteristics of a computer network in automotive industry (reliability, determinisms, efficiency, rate, security, user requirements dependence on component characteristics and their critical level). The main protocols and bus protocols used in automotive industry (basic information and studying practical protocols and bus technologies: CAN / CAN-FD, LIN, FlexRay, NAJ, BroadR doseg, deterministic Ethernet, detailed comparison of protocols and typical usage). Advanced topics: communication between two or more vehicles and communication between a vehicle and infrastructure.	
1.5. Teaching methods	Lecture Laboratory exercises Construction exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	

1.8. Course assessment

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises, Design exercises	2	1,2,3,4	Lectures, Laboratory exercises, Design exercises	Attendance register. Mandatory attendance percentage is: 70%.	2	4
Writing pre-lab write-ups, results analysis and writing laboratory reports	1.5	3,5	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	15	30
Oral exam	2	1,2,3	Oral exam	Assessment of student's answers	20	40
Problem-solving related to design exercises	1.5	3,5	Design exercises	Evaluation of problem solving exercises	13	26

1.10. Obligatory literature

1. Bažant, A i ostali. Osnovne arhitekture mreža. Zagreb: Element, 2014
2. Di Natale, Marco i ostali Understanding and Using the Controller Area Network Communication Protocol – Theory and Practice, Springer New York, 2014.

1.11. Recommended additional literature

1. Dominique Paret: Multiplexed Networks for Embedded Systems: CAN, LIN, FlexRay, Safe-byWire, SAE International and John Wiley & Sons, 2007.
2. Raul Aquino-Santos, Arthur Edwards, Victor Rangel-Licea, Wireless Technologies in Vehicular Ad Hoc Networks: Present and Future Challenges, IGI Global, 2012
3. Tanenbaum, A. S; Wetherall, D. J. Computer Networks (5. izdanje). Boston: Prentice Hall, 2011.
4. I. Lovrek: Modeli telekomunikacijskih procesa - Teorija i primjena Petrijeve mreže, Školska knjiga, Zagreb, 1997.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Doc.dr.sc. GRGIĆ KREŠIMIR	
Course name	DA3-05 Security of Information Systems	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Workload (L+(AE+LE+CE)+S)	30+(15+15+0)+0

1. Course description	
1.1. Goals	
Familiarise students with fundamental security issues in information systems (understanding of possible security threats, attacks and risks), with an emphasis on information and communication systems used in vehicles. Teach students to understand fundamental principles of modern cryptography and their practical applications in security protocols used in communication within a vehicle, intervehicular communication, as well as in communication of vehicles with fixed infrastructure. Train students to plan the implementation of proper security mechanisms in vehicular networks.	
1.2. Conditions for enrollment	
The necessary requirements to enrol in the second year of the studies.	
1.3. Learning outcomes	
1.understand and describe fundamental principles of modern cryptosystems and their possible applications in vehicular information systems 2.understand and explain security risks, threats and possible attacks on vehicular information systems 3.implement and apply different security mechanisms on a vehicular information system model 4.understand and apply security communication protocols used in vehicles 5.make a model of a security mechanism application in wireless intervehicular communication, as well as in communication of vehicles and infrastructure	
1.4. Course content	
Fundamental security terms and premises. Fundamental principles of modern cryptography. Symmetric cryptosystems and their applications. Block cipher operating modes. Asymmetric cryptosystems and their applications. Cryptographic hash functions. Digital signature. Cryptographic key management. Security threats and risks in vehicular information systems. Types of attacks on vehicular information systems and possible countermeasures. Security protocols for wired and wireless communication standards used in vehicular networks. IEEE 1609 security standards. Privacy issues in vehicular networks. Mechanisms for secure positioning of vehicles. Cross-layer security approach, from system boot to intervehicular communication.	
1.5. Teaching methods	Lecture Auditory exercises Laboratory exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	

1.8. Course assessment

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Auditory exercises, Laboratory exercises	1.5	1,2,3,4,5	Lectures, Auditory exercises, Laboratory exercises	Attendance register. Mandatory attendance percentage is: 70%.	1	4
Practice – problem solving	1.1	1,2,4	Midterm exam	Evaluation of (written) exercises	16	32
Writing pre-lab write-ups, results analysis and writing laboratory reports	1	3,4,5	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	12	24
Oral exam	1	1,2,3,4	Oral exam	Assessment of student's answers	15	30
Seminar paper	0.4	1,3,4,5	Team work	Supervision of a teacher. Checking solutions	6	10

1.10. Obligatory literature

1. W. Stallings, Cryptography and Network Security – Principles and Practice, Paerson, Boston, 2016.
2. M. Wolf, Security Engineering for Vehicular IT Systems, Springer, 2009.

1.11. Recommended additional literature

1. K. Lemke, C. Paar, M. Wolf, Embedded Security in Cars, Springer, 2006.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Doc.dr.sc. VRANJEŠ MARIO, Doc.dr.sc. GRBIĆ RATKO	
Course name	DA3-03 Machine Learning in Systems of Autonomous Networked Vehicles	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Workload (L+(AE+LE+CE)+S)	30+(0+15+15)+0

1. Course description	
1.1. Goals	
Introduce students to principles of data analysis and machine learning methods. Enable students to apply machine learning methods in intelligent transport systems of autonomous and networked vehicles, focusing on image processing and deep learning. Acquire appropriate skills for work with development tools for data analysis and machine learning, as well as with development tools that enable the implementation of the developed algorithms to the target platform.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.define basic terminology and the concept of machine learning 2.differentiate machine learning types 3.develop your own software solution using appropriate libraries that contain implemented methods and machine learning algorithms 4.classify, explain and analyse deep neural networks architectures and deep learning algorithms 5.choose and apply appropriate methods and deep learning models to solving specific problems in intelligent transport systems 6.adjust your own software solution based on deep learning methods for implementation on the target platform	
1.4. Course content	
Introduction to machine learning. Unsupervised, supervised learning and reinforcement learning. Parametric and nonparametric methods. Regression and classification methods. Model complexity. Model selection. Results evaluation. Different methods / algorithms of supervised machine learning: linear regression, neural networks, support vector machines, decision trees, random forests. Data clustering, dimensionality reduction and feature extraction. Kalman filter and Bayesian estimation. Anomaly detection. The basics of deep learning. Architectures and deep learning algorithms. Different types of deep neural networks. Convolution Neural Networks. Different applications of machine and deep learning in intelligent transport systems: fusion of sensor inputs, segmentation, detection and classification of objects (signs, lines, pedestrians, etc) in the image, motion planning, learning with and without the driver, local autonomous vehicle control, centralised and distributed control of networked vehicles. Work with development tools that support machine learning and deep learning. Implementation of machine learning algorithms on the target platform.	
1.5. Teaching methods	Lecture Laboratory exercises Construction exercises
1.6. Comments	

1.7. Student obligations

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.8. Course assessment

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Laboratory exercises, Design exercises	1.5	1,2,3,4,5,6	Lectures, Laboratory exercises, Design exercises	Attendance register. Mandatory attendance percentage is: 70%.	0	5
Writing pre-lab write-ups, results analysis and writing laboratory reports	1	2,3,5,6	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	15	25
Oral exam	1	1,2,4,5	Oral exam	Assessment of student's answers	20	40
Problem-solving related to design exercises	1.5	3,5,6	Design exercises	Evaluation of problem solving exercises	0	30

1.10. Obligatory literature

1. I. Goodfellow, Y. Bengio, A Courville, Deep Learning, MIT Press, 2016.
2. E. Alpaydin, Introduction to Machine Learning, MIT Press, 2014.

1.11. Recommended additional literature

1. S. Raschka, Python Machine Learning, Packt Publishing, 2015.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Doc.dr.sc. KESER TOMISLAV	
Course name	DA3-01 Practical Training	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	9
	Workload (L+(AE+LE+CE)+S)	0+(0+0+200)+0

1. Course description	
1.1. Goals	
Introduce students to the work environment in a company, organisational structure of a production system, managers and their responsibilities, production technology, as well as to the prescribed measures and workplace health and safety procedures that are related to the production technology of the company. Students get acquainted with engineering jobs and tasks, and can be actively involved in these jobs under supervision of the assigned mentor, while respecting safety measures, professional and technological rules, as well as other company rules. Upon completion of the practice, students prepare a report on the performed practice, which should be in line with the common technical communication form.	
1.2. Conditions for enrollment	
The necessary requirements to enrol in the second year of the studies.	
1.3. Learning outcomes	
1.recognise the organisational structure of a production system, as well as tasks and role of the manager 2.recognise engineering tasks, as well as the required knowledge and skills related to the company production technology 3.learn the prescribed measures and workplace health and safety procedures that are related to the production technology of the company 4.name the most important regulations and norms related to the technology used by the company 5.master technical writing and documentation skills which are important in engineering communication	
1.4. Course content	
Practical training lasts for 200 hours (13 hours per week on average). Each student does his/her own training in a company and is involved in jobs that are related to his/her study course. Under supervision of their mentors, students get acquainted with the organisational structure of a production system, production technology and workplace health and safety procedures. Furthermore, they are involved in engineering tasks, complying with safety measures, professional and technological rules, as well as other company regulations. During the training, students keep a work diary. Practical training is organised by the Faculty in cooperation with engineers that are employed in companies whose business activities are closely related to the study programmes. The Faculty appoints those engineers as mentors and they jointly prepare the training programme. Practical training is organised in accordance with the Faculty's Regulation on students' practical training.	
1.5. Teaching methods	Construction exercises
1.6. Comments	
1.7. Student obligations	

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.8. Course assessment

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance , Design exercises	6.5	1,2,3,4	, Design exercises	Attendance register. Mandatory attendance percentage is: 70%.	32	40
Problem-solving related to design exercises	1.5	1,2,3,4	Design exercises	Evaluation of problem solving exercises	15	30
Writing a report on realized practice	1	5	Practical training	Evaluation by the subject bearer	15	30

1.10. Obligatory literature

1. Pravilnik o stručnoj praksi studenata Elektrotehničkog fakulteta Osijek
2. Propisi o zaštiti na radu u RH

1.11. Recommended additional literature

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).

General information		
Lecturer	Doc.dr.sc. KESER TOMISLAV	
Course name	DARab2-04-17 Embedded Computer Systems	
Study program	Graduate study programme, branch: Automotive Computing and Communications (mandatory)	
Course status	Mandatory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Workload (L+(AE+LE+CE)+S)	30+(15+15+0)+0

1. Course description	
1.1. Goals	
Familiarise students with the versatility and ubiquity of digital computer systems usage in applications that are not solely intrinsically related to computing and processing information. Show them principles of analysis, definition and synthesizes of computer systems for specialised use as a function of managing and / or control of real processes that utilise appropriate computer architecture. Teach them to recognise, analyse, define, and design digital control systems based on microcomputers, microprocessors and /or DSP systems. Familiarise students with the basic principles of programming of embedded computing systems, circuit design, realisation and application in real control systems.	
1.2. Conditions for enrollment	
Requirements met for enrolling in the study programme	
1.3. Learning outcomes	
1.distinguish computer systems based on microprocessors, micro-controllers and digital signal processors 2.explain application properties of a microprocessor, micro-controller and DSP in embedded applications 3.define and evaluate requirements, and choose an embedded computer system based upon application requirements 4.analyse and evaluate the applicability of an embedded real-time computer system 5.design software support according to application requirements 6.design hardware of an embedded computer system by using CAD tools	
1.4. Course content	
Basic concepts in computer science. Architecture and organisation of microprocessors, microcontrollers and digital signal processors. Characteristic features and specifics of embedded computing systems. Structure and incorporation of embedded computing systems. Hardware development equipment. Design of printed circuit boards. Software development equipment. Reliability and security of embedded systems. Testing, verifying and validating embedded systems. Applications of embedded systems. Application in intelligent measurement processes. Application in process management. Application in monitoring, acquisition and data distribution.	
1.5. Teaching methods	Lecture Auditory exercises Laboratory exercises
1.6. Comments	
1.7. Student obligations	
Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9	

1.8. Course assessment

Defined by the Student evaluation criteria of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and paragraph 1.9

1.9. Assessment and evaluation of the students' work during the semester and on the final exam

Student's activity	ECTS	Learning outcomes	Teaching method	Assessment method	Points	
					Min	max
Attendance Lectures, Auditory exercises, Laboratory exercises	1.5	1,2	Lectures, Auditory exercises, Laboratory exercises	Attendance register. Mandatory attendance percentage is: 70%.	3	10
Practice – problem solving	1	1,2,3,4	Midterm exam	Evaluation of (written) exercises	10	20
Writing pre-lab write-ups, results analysis and writing laboratory reports	0.5	2,3	Laboratory practice	Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports	0	10
Oral exam	0.5	1,2,3,4	Oral exam	Assessment of student's answers	15	30
Project design	2.5	3,4,5,6	Project assignment	Designing and presenting an embedded computer system	0	30

1.10. Obligatory literature

1. E. White, Making Embedded Systems, O'Reilly Media, 2011. (ISBN 978-1-4493-0214-6)
2. E. A. Lee, S. A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Edition 1.5, 2014. (ISBN 978-0-557-70857-4)

1.11. Recommended additional literature

1. Roger Young, How Computers Work: Processor and Main Memory, Roger Stephen Young, 2001.
2. Sophocles J. Orfanidis, Optimum Signal Processing, Rutgers University, 2nd Edition, 2007., eBook (free)
3. Michael J. Pont, Patterns for Time-Triggered Embedded Systems, Addison-Wesley, 2014.

1.12. Monitoring of students

Conducting university questionnaires on teachers (student-teacher relationship, transparency of assessment criteria, motivation for teaching, teaching clarity, etc.). Conducting Faculty surveys on courses (upon passing the exam, student self-assessment of the adopted learning outcomes and student workload in relation to the number of ECTS credits allocated to activities and courses as a whole).