SVEUČILIŠTE JOSIPA JURJA STROSSMAYERA U OSIJEKU
ELEKTROTEHNIČKI FAKULTET OSIJEK

# Graduate university study programme in Computer Engineering

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

Osijek, 2015
(version 2019/2020)

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# 1 INTRODUCTION

The graduate study programme in Computer Engineering has been carried out at the Faculty of Electrical Engineering Osijek since the academic year 2008/2009.

After seven years of carrying out the study programme and in addition to considering the interest and the needs of labour market, wider social community, students' interest and employees' scientific advancement, we have decided to suggest amendments to the study programme.

The amendments to the graduate university study programme in Computer Engineering will not affect the number of enrolled students, i.e. students will enrol in the following four elective modules:
DR1 – Computer Engineering
DR2 – Process Computing
DR3 – Software Engineering
DR4 – Information and Data Science

## 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 Osijek

Address:
Kneza Trpimira 2b
31 000 Osijek

Telephone:
+385 31 224 600

E-mail address:
etf@etfos.hr

Website:
http://www.etfos.unios.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 Osijek, Josip Juraj Strossmayer University of Osijek adopted the report entitled "Proposition of amendments to the graduate university study programme in Computer Engineering" at its 177th session held on 5th May, 2015 (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 Computer Engineering is greatly based on the current graduate university study programme thus preserving the initial comparison with the quality of related accredited study programmes in the Republic of Croatia and the European Union countries.

The graduate university study programme in Computer Engineering is comparable with the majority of contemporary graduate study programmes in the Republic of Croatia as follows:

- graduate university study programme in Computing, branch Software Engineering and Information Systems at the Faculty of Electrical Engineering and Computing, University of Zagreb (http://www.fer.unizg.hr/diplomski_studij/rac). To illustrate, the learning outcomes of the proposed study programme are greatly comparable to the learning outcomes of the following courses:
  - Basic Use of Linux Operating System, S. Groš
  - Advanced Algorithms and Data Structures, D. Kalpić, N. Hlupić
  - Computers and Processes, M. Žagar, I. Čavrak
  - Computer Graphics, Ž. Mihajlović
  - Computer Vision, S. Ribarić
  - Distributed Systems, I. Lovrek, M. Kušek, I. Ž. Podnar, K. Pripužić
  - Discrete Mathematics, M. Krnić
  - PHP Application Development Basics, M. Čupić
  - Formal Methods in System Design, A. Đerek, B. Blašković
  - Advanced Operating Systems, M. Golub
  - Digital Image Processing Analysis, S. Lončarić
  - Computer Systems Reliability, V. Sruk
  - Operating Systems for Embedded Computers, L. Jelenković
  - Real-Time Systems, L. Jelenković
  - Project Management, K. Fertalj, Ž. Car

- graduate university study programme in Computing, branch 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:
  - Computing Models, J. Ožegović
  - Numerical Analysis, I. Slapničar
  - Computer Graphics, V. Papić
  - Advanced Computer Architecture, S. Gotovac
  - Grid Computing Systems, E. Mudnić
  - Embedded Systems, S. Gotovac
  - Digital Image Processing and Analysis, D. Stipaničev, D. Krstinić
  - Project Management, I. Veža

- graduate university study programmes at the Faculty of Organization and Informatics, University of Zagreb (http://www.foi.unizg.hr/buduci-studenti/upisi/upisi-ds/ds_foi). To illustrate, the learning outcomes of the proposed study programme are greatly comparable to the learning outcomes of the following courses:
    - Software Analysis and Design, V. Strahonja, N. Vrček
    - Logic Programming, M. Čubrilo
    - Operating Systems 2, M. Golub
    - Advanced Web Technologies and Services, D. Kermek
    - Intelligent Systems, K. Božidar
    - Computer Graphics, I. Hip

Additionally, the study programme is comparable to study programmes carried out at European universities (see Chapter 3.21 for a detailed comparison):

- Vienna University of Technology, Vienna, Austria, Master programme in Computer Engineering, Master programme in Visual Computing:
  https://www.tuwien.ac.at/en/teaching/master_programs/

- University of Maribor, Faculty of Electrical Engineering, University of Maribor, Slovenia, Computer Science and Information Technologies, Informatics and Technologies of Communication:
  http://www.feri.um.si/en/study/programmes/

- Department of Computer Science, York University, UK, MSc in Computing, MSc in Software Engineering:
  http://www.cs.york.ac.uk/postgraduate/

- Innovation, Design and Engineering Institute, Malardalen University, Sweden, Master Programme in Intelligent Embedded Systems:
  http://www.mdh.se/utbildning/program/master-embedded?programCode=GST01

- Saarbrücken Saarland University, Department of Computer Science
  http://www.uni-saarland.de/en

- University Paderborn, Computer Engineering, Department of Computer Science
  http://www.cs.uni-paderborn.de/studierende/studiengaenge/computer-engineering.html

The study programmes are generally comparable because they last for two years, students acquire the same number of ECTS credits (120) and the academic title of the Master of Computer Engineering is fully comparable in the Republic of Croatia and other European Union countries. The evidence of comparability is successful incoming and outgoing student mobility within Erasmus mobility programmes. Mobility will be continued because the basic compliance assumptions with the Bologna process will not be altered.

In addition to other Faculty employees, the teaching process quality will be ensured by 36 teachers and associates affiliated to two 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 Chair of Automation and Robotics;
- Department of Software Engineering which consists of the Chair of Programming Languages and Systems and Chair of Visual Computing.

High quality computing, measuring and simulation equipment is provided in these Departments. The equipment has already been and will be used in the following teaching laboratories which are continually being upgraded – Computer Graphics and Mathematical Image Processing Laboratory, Laboratory for Automation and Robotics and Laboratory for Digital Electronics and Computer Architecture (see 7.2).

A special emphasis should be put on the current quality assurance system. The Faculty of Electrical Engineering Osijek continuously evaluates the employees' work. It conducts both university and faculty questionnaires on teachers and undertakes a number of activities related to quality assurance.

The provided comparison of the graduate university study programme in Computer Engineering with similar study programmes points to high compatibility, which will enhance mobility of students studying at the University of Osijek and other Croatian universities as well as the majority of European universities.

## 3 GENERAL INFORMATION ON THE STUDY PROGRAMME

### 3.1 Name of the study programme
Graduate university study programme in Computer Engineering

### 3.2 Provider of the study programme
Josip Juraj Strossmayer University of Osijek, Faculty of Electrical Engineering 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
Computer Engineering

### 3.7 Scientific or artistic branch
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 Computer Engineering can be enrolled into by students who graduated from the Faculty of Electrical Engineering Osijek and are awarded the following titles:

- University Bachelors of Computer Engineering;
- Bachelors who passed all differential exams at the Faculty of Electrical Engineering Osijek thus meeting the requirements for enrolling in the graduate university study programme in Computer Engineering.

The graduate university study programme in Computer Engineering can also be enrolled into by:

- University Bachelors of Computer 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 study programme in Computer Engineering, students are awarded an academic title of Master of Computer Engineering.

### 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 Computer Engineering from the Faculty of Electrical Engineering Osijek have been trained to carry out the following activities:

- designing and developing hardware and software solutions of computer systems for economy, industry, business and other applications in companies;
- designing hardware and software solutions;
- working in public administration and research institutions;
- working individually and in teams to provide creative and systematic solutions of complex engineering problems in computer and software engineering;
- conducting laboratory research;
- planning and optimising contemporary hardware and software solutions.

Since the branch is divided into four elective modules and taking into account chosen courses of the selected elective module, students acquire the following additional competencies:

Elective module Computer Engineering:

- designing and building components (processor), computer components and complex structures;
- developing application programs in hardware describing programming languages (VHDL, etc.);
- developing application programs for microprocessors and microcontroller embedded systems and computer components, automatic control systems;
- designing software solutions and algorithms for signal processing by using DSP;
- developing, designing and diagnosing DSP-based embedded computer systems;
- designing, developing, controlling and maintaining computer networks;
- carrying out a reliability analysis of computer systems by using integrated software tools, failure calculations, parameters of maintaining and availability, analysis of sensitivity to component malfunction, fault tree analysis, etc.;
- carrying out malfunction diagnostics and fault analysis as well as suggesting improvements for architecture and software support;
- testing software support quality;
- applying procedures of computational intelligence for specific tasks in data analysis;
- designing and developing environments for the Internet of Things;
- applying basic knowledge in the field of artificial intelligence and recognising patterns required for applications and implementations of such systems in solving engineering problems;
- programming and developing application programs for high performance distributed systems (service-oriented architecture, computer clusters, computer clouds);

- developing, documenting and creating databases;
- developing, documenting and creating information systems;
- developing, designing and programming mobile applications;
- implementing digital regulators based on standard and advanced automatic control methods;
- acquiring basic working principles and developing programs for programmable logic controllers;
- acquiring basic working principles and developing controlling software for robotic manipulators and mobile robots;
- using distributed computing systems based on current hardware and software technologies;
- acquiring basic knowledge to manage corporate and personal companies, lead engineering and development expert teams and manage projects.

Elective module Process Computing:

- basic knowledge required to develop and implement process and machine control systems;
- the ability to systematically design control circuits starting with determining a mathematical model of the process, through theoretical analysis and experimental identification, to determining the regulator structure and parameters by various synthesis methods;
- the ability to implement digital controllers based on standard and advanced automatic control methods;
- basic knowledge of digital signal processing;
- basic knowledge in the field of artificial intelligence and identification of samples necessary for recognition of the possibility of application and implementation of such systems in solving technical problems;
- knowledge of the basics of operation and the ability to design programmable logic controller (PLC) software;
- basic knowledge required to develop control software for robotic manipulators and mobile robots;
- basic knowledge of the selection and design of computer-based communication systems based on busbars or local networks;
- the ability to understand how a computer system functions and to independently design the system in question or its parts;
- basic knowledge necessary for material selection, design and development of specialised real-time computer systems for controlling more or less complex processes;
- the ability to use and build distributed computer systems based on current circuit and programming technologies;
- knowledge necessary for company management and independent entrepreneurial activity, the ability to run engineering and development teams of experts and the ability to manage projects;
- basic knowledge in the field of image processing and computer vision;
- more detailed knowledge of control system equipment, in particular with regard to the selection and application of measuring and executive components as the ultimate elements of the control system.

Elective module Software Engineering:

- developing application programs in high-level procedural and object-oriented programming languages;
- testing software support quality;
- applying computational intelligence procedures for specific tasks in data analysis;
- designing and developing environments for the Internet of Things;
- designing, building and testing real-time computer systems;
- designing and implementing heterogeneous computing platforms;

- programming and developing application programs for high-performance distributed systems (service-oriented architecture, grids, clouds);
- creating and designing web sites and related databases (php, ASP, SQL);
- designing and implementing energy efficient distributed computer systems with increased self-sustainability (autonomous computer systems) for industrial and business applications;
- designing and implementing computer systems and software solutions for text and image processing;
- developing and designing documentation and creating databases;
- developing and designing documentation and creating information systems;
- designing and implementing computer systems in biomedicine and health care;
- developing, designing, and programming mobile applications;
- education in the fields of developing and designing mobile applications, design and maintenance of computer networks, programming languages, web technologies and user packages.

Elective module Information and Data Science:
- developing ICT solutions;
- research, development and application of methods of analysis and synthesis of computer systems, mathematical modelling, computer simulation and optimisation;
- development and application of software support for processing, storing and analysing data collected from different sources;
- developing software solutions by applying and combining different web technologies;
- project planning and management and preparing project documentation;
- leading project teams;
- developing applications in the fields of medical data processing, simulation, computer game design, robotics, agriculture and other areas of human-computer interaction;
- developing, adapting and implementing modern computer technologies by linking knowledge from different areas and integration into unique computer systems;
- designing and implementing computer systems and software solutions for text and image processing;
- developing and designing documentation and creating databases;
- developing and designing documentation and creating information systems.

**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.

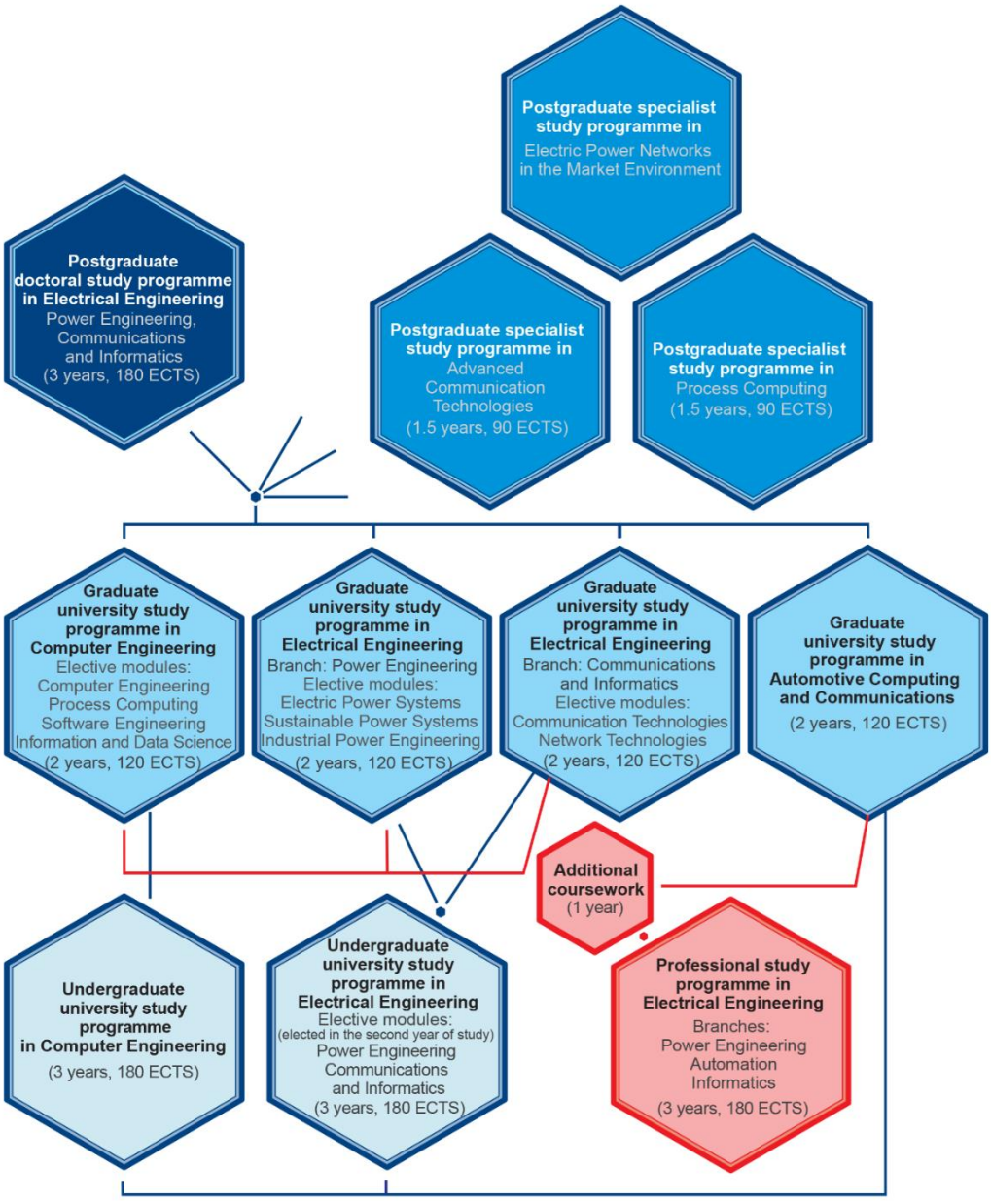


Figure 1. Vertical studying scheme at the Faculty of Electrical Engineering Osijek

Masters of Computer Engineering who completed the graduate university study programme in Computer Engineering are eligible to enrol in the postgraduate university specialist or doctoral study programmes in Computer Engineering at the Faculty of Electrical Engineering Osijek (Figure 1) and at other related higher education institutions in the Republic of Croatia or abroad.

International student mobility during their studies is provided by the ERASMUS mobility programme carried out at the University since the academic year 2009/2010.

### 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 every academic year in the fourth semester. For example, in the academic year 2014/2015, there were 35 courses offered by 17 University constituent units.

### 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. 24 courses can be taught in the English language.

### 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 Computer Engineering was designed based on our own recognition of the need to innovate and modernise teaching contents, to follow the demands of the broader community and to build a number of contacts and cooperation with colleagues from other Croatian and foreign universities. The graduate university study programme in Computer Engineering offered by the Faculty of Electrical Engineering Osijek is based on contemporary professional programmes of Croatian and European universities: in terms of the content and qualifications, it is fully comparable with the study programmes of other Croatian universities and comparable with the study programmes at some European universities.

The graduate university study programme in Computer Engineering was designed to educate experts on the design and development of modern automated systems and intelligent computer systems. To this end, a curriculum was developed that provides the basic knowledge necessary to understand the basic principles of process modelling, control algorithm design, digital signal processing, sample recognition, which is then expanded to more advanced knowledge in the fields of artificial intelligence, metric data modelling and robotics. The study programme also extends the knowledge of automatic control acquired in the undergraduate study programme and offers practical knowledge and skills necessary for the development of real-time and embedded computer systems.

We are witnessing a rapid expansion of intelligent computer systems applied in industrial production, cars and transport in general, agriculture and everyday life. Modern automated systems represent complex information systems that include computers linked to communication networks, which, through processing information obtained through sensors, independently control processes, ensuring cost-effectiveness and high production quality in industrial applications. Technical process control requires real-time operation, and the application of embedded computer systems is extended to standalone devices and machines. Artificial intelligence systems, robots, soft sensors, and computer vision have been increasingly used today. Hence this study programme was designed to provide students with a wide range of knowledge in the fields of automatic control, data processing, sensors and computer equipment applied in automated systems. Students are also taught how to follow the latest scientific achievements that are potentially applicable in process automation, such as artificial intelligence. Finally, the process of education is closed by teaching the students how to run projects or manage companies or departments, providing the necessary knowledge of management and project management.

Through a wide range of elective modules and depending on their personal interests, students are able to enhance their knowledge in the field of computing, intelligent systems, data processing, robotics, computer networks, computer vision and soft sensors, improve their skills required for organisation, analysis and presentation of data, as well as the development of computer, information and software systems in line with the latest trends in science and technology.

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

It is expected that the study will meet the needs of the local community for new jobs in terms of reducing unemployment.

Namely, the analysis of labour market data in Croatia shows that experts who complete the graduate university study programme in Computer Engineering find employment much faster, even in conditions of high unemployment. Computer engineering constitutes an important foundation for the development of every society, and the Faculty of Electrical Engineering Osijek is the only institution in Eastern Croatia that educates experts in this area, which is thus the foundation for future successful education of experts in the field of computer engineering, 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.

The content of the proposed graduate university study programme in Computer Engineering includes analysis, design, construction, testing and maintenance of modern hardware and software solutions in computer systems. With regard to numerous companies in Osijek, its surroundings, and Croatia in general, that deal with these activities, 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, the fields of computer engineering, process engineering, software engineering, and information processing are covered now by introducing elective modules, modernising the existing ones, and introducing new elective courses. Over the last few years, a number of companies have been established in Osijek or have come to do business in Osijek, that are primarily engaged in the development of software solutions in modern computer environments as well as in processing of all forms of data for business, industrial and all other applications interesting not only to the local community, but also to the global market. Also, there are companies involved in the development, design and implementation of automation and process control solutions. By completing one of the elective modules in the graduate university study programme in Computer Engineering, Masters of Computer Engineering

would have an appropriate level of knowledge and competencies in the aforementioned areas, and the local community would certainly benefit from them. Conversations with companies, students, and graduates have implied great interest in launching such study programme in computer engineering.

Slavonia has always been the breadbasket of Croatia and the main food producer, and Osijek was an industrial city as early as in the 19th century. Thus, the region in which the Faculty of Electrical Engineering Osijek operates is focused on production, has production capacity and depends on production. Unfortunately, in the last two decades there has been strong deindustrialisation of Slavonia and Osijek, which has directly caused the drastic fall in living standards and excessive unemployment of the population living in this region. Because of this current state of affairs, there is growing awareness of the need to start production, both in food and other industries. Recently, apparent growth has been recorded in the computing industry in Osijek, which needs to expand to new areas of application.

The elective modules offered within the graduate university study programme in Computer Engineering fit perfectly into the reindustrialisation plan of Osijek, Slavonia and Croatia, and complement the growing computing sector with the necessary knowledge in the field of intelligent systems. This is a study programme focused on the application of computers in control of various types of processes occurring in industrial and agricultural production and transportation, and its curriculum is designed to educate not only expert, but also innovative staff for whom there is a great need in Croatia. Production in both Europe and Croatia cannot be competitive if it is not highly automated. Education and training of experts in the fields of automation and intelligent systems who will be able to keep track of global technological trends and apply the state-of-the-art technology in production is extremely important for boosting the competitiveness of Croatian export capacities in the European and global market.

Elective modules should primarily help students develop knowledge and skills in the field of designing computer systems, components and computer system structures, i.e. emphasis is placed on hardware, computer architecture and computer system architecture. There is a high demand for planning and designing for the existing productions companies in Slavonia and Baranja which are involved in building embedded computer systems applied in transport, domestic train-manufacturing industry, automotive industry for foreign manufacturers, computer-controlled machines and machine tools, etc. Some courses offered in the elective modules deal with signal processing and application to digital signal processors (DSP). Furthermore, some companies are interested in DSP algorithm development in the field of digital television, signal processing, robotics, manipulators and automated control in the automotive industry for foreign equipment manufacturers.

The upward trend of using service-oriented architecture (SOA) will continue to grow because it increases functionality, adaptability and interoperability of complex IT solutions. Consequently, there is an increasing need for staff skilled to work in this subsector, especially educated computer experts able to develop applicative solutions. Also, the demand for programmers and web technology professionals, including the development of mobile applications which create and use information available on the Internet, but also enable interactivity and display of multimedia content, is on the constant rise. There is also a growing need for using distant resources and access to remote applications and data warehouses, which, apart from communications technologies and a quality network support, require adequate level of knowledge of computer system experts who will maintain these systems. The study programme is adjusted to the local community demand for computer experts who are able to adjust to interdisciplinary fields of work.

The graduate university study programme in Computer Engineering 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 skills in the field of computer engineering, including all its narrow specialised fields, are related to all areas of work and living as well as to strategic areas important for community sustainability. All elective modules offered in the branch of Computer Engineering qualify future employees for computer programming which is the main driver of employment in our local community. Even during recession, there was not a decline of computer programming jobs. As a matter of fact, the demand is expected to be dynamic. The study programme in Computer Engineering meets the challenge of rapid development of new technologies and their applications, demand for new skills, human potential development aimed at employment and economic growth.

Together with the undergraduate university study programme in Computer Engineering, the graduate university study programme in Computer Engineering forms a logical unit in the education of experts in this field. Graduates holding a Master's degree in Computer Engineering are skilled to face complex problems in research and development, as well as application of new technologies in computing and ICT sector. There are huge employment opportunities in the application of computer engineering from large systems to small businesses.

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

The Department of Computer Science at Technical University of Kaiserslautern covers the following fields:

- Computer Graphics and Visualisation
- Development of Embedded Systems
- Information and Communication Systems
- Intelligent Systems
- Robotics
- Software Engineering

Courses similar to ours offered in elective modules DR1 and DR2:

- Computer Systems 1
- Computer Systems 2
- Software Quality Assurance
- Safety and Reliability of Embedded Systems
- Fundamentals of Embedded systems
- Processor Architecture
- Build Your Own Supercomputer
- Intelligent Systems
- Virtual Prototyping and HW/SW Co-Design
- Fundamentals of Robotics
- Machine Learning

and in elective modules DR3 and DR4:

- Web 2.0 Technologies,
- Web Technology
- Computer Graphics

- Computer Animation
- Scientific Visualization
- Information Visualization
- Distributed and Networked Systems
- Hardware-Software Systems
- Application of Artificial Intelligence
- 3D Computer Vision

The University of Oxford, England, has a Department of Computer Science and a list of courses comparable to our courses in elective modules DR1 and DR2 is given below:

- Computer Architecture
- Intelligent Systems
- Machine Learning
- Probability and Computing
- Software Verification

and in elective modules DR3 and DR4:

- Automata, Logic and Games
- Computer Animation
- Computer Graphics
- Discrete Mathematics
- Intelligent Systems
- Theory of Data and Knowledge Bases
- Visual Analytics

Courses offered in elective modules DR1 and DR2 correspond to the following courses taught at the Department of Computer Science and Technology at the University of Cambridge, England.

- Hardware Practical Classes
- Computer Design
- Computer Networking
- Artificial Intelligence
- Digital Signal Processing
- Comparative Architectures
- Computer Vision
- System on Chip Design

and in elective modules DR3 and DR4:

- Discrete Mathematics
- Operating System
- Software and Interface Design
- Computer Graphics and Image Processing
- Concurrent and Distributed Systems
- Information Theory and Coding
- Advanced Graphics
- Computer Vision
- System-on-Chip Design

A list of courses at the School of Computer and Communication Sciences, Ecole Polytechnique Fédérale de Lausanne, Switzerland, which is comparable to our courses in elective modules DR1 and DR2, is given below:

- Computer Vision
- Design Technologies for Integrated Systems
- Pattern Classification and Machine Learning
- Advanced Computer Construction
- Advanced Multiprocessor Architecture
- Biological Modelling and Neural Networks
- Industrial Automation
- Microelectronics for SoC
- System on Chip Design

and in elective modules DR3 and DR4:

- Distributed Algorithms
- Distributed Information Systems
- Information Theory and Coding
- Advanced Computer Graphics
- Digital 3D Geometry Processing
- Distributed Intelligent Systems
- Image and Video Processing
- Image Processing I
- Image processing II

The high level of correspondence of the proposed graduate university study programme in Computer Engineering with the aforementioned 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.

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

- pre-Bologna professional study programme in Electrical Engineering: 1062
- pre-Bologna university study programme in Electrical Engineering: 950
- undergraduate university study programme in Electrical Engineering: 687
- undergraduate university study programme in Computer Engineering: 432
- undergraduate professional study programme in Electrical Engineering: 608
- graduate university study programme in Electrical Engineering: 414
- graduate university study programme in Computer Engineering: 204
- postgraduate doctoral study programme in Electrical Engineering: 48

Amendments to the study programme have been proposed based on our own cognition about the need to modernise the teaching content and adjust it to the labour market requirements, as well as owing to

contacts and conversation with colleges from other (Croatian and foreign) universities, analysis results of study success and feedback from our alumni.

### 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 graduate university study programme in Computer Engineering is based upon a better connection with the economy and it follows the latest technology developments. Through participation of external associates in field-based learning, implementation of practical training and writing of Master's theses, the following partners, whose business activities are in the field of computer engineering, would be involved in the proposed study programme: Končar elektronika i informatika d.d.(Končar Electronics and Informatics), Zagreb; Siemens Convergence Creators d.o.o., Siemens d.d., Zagreb; Osijek; Belišće d.d.-Electrical Equipment Production, Belišće; SPAN d.o.o., Zagreb; Danielli-Systec d.o.o., Osijek; ATO inženjering d.o.o., Osijek; Saponia Osijek d.d, etc.

In addition, employees of the RT-RK Institute Osijek would participate in professional and practical training of students through writing of final papers and Master's theses, maximising engineering potential through training and project development, as well as additional education of 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 semester-based graduate university study programme in Computer Engineering is composed of four semesters, i.e., two years of study.

When enrolling on the study programme, students can opt for the following four elective modules:
DR1 – Computer Engineering
DR2 – Process Computing

DR3 – Software Engineering
DR4 – Information and Data Science

The existing graduate university study programme in Computer Engineering forms the basis for the amended study programme. Therefore, the compulsory courses held at the present study programme are represented in each semester in all elective modules as follows:

- in Semester 1, out of four compulsory courses of the existing study programme, at least three courses are taught in every elective module
- in Semester 2, out of three compulsory courses of the existing study programme, at least two of them are present in each elective module
- in Semester 3, out of three compulsory courses of the existing study programme, at least two of them are present in each elective module
- in Semester 4, both compulsory courses of the existing study programme are compulsory in each elective module, including the work on the Master's thesis.

In accordance with the elective module, a student enrols on courses specific to the respective elective module as described below. Depending on the intended competences, some courses can, however, be taught in other elective modules as well. Structuring the elective courses as elective modules does not only enable specialisation of students according to their interests, but also a narrower specialisation within the respective branch.

Semester 1 and Semester 2 consist of five courses per each elective module.

Semester 1:

| | Course 1 | Course 2 | Course 3 | Course 4 | Course 5 |
|---|---|---|---|---|---|
| DR1 | Computer System Design | Automation and Formal Languages | Control of Dynamic Systems | Digital Signal Processing | DSP Processor Algorithms and Architecture |
| DR2 | Computer System Design | Automation and Formal Languages | Control of Dynamic Systems | Digital Signal Processing | Pattern Recognition and Machine Learning |
| DR3 | Computer System Design | Automation and Formal Languages | Discrete Mathematics | System Programming | Software System Design and Modelling |
| DR4 | Computer System Design | Automation and Formal Languages | Discrete Mathematics | System Programming | Image Processing and Computer Vision |

Semester 2:

| | Course 1 | Course 2 | Course 3 | Course 4 | Course 5 |
|---|---|---|---|---|---|
| DR1 | Real-time Computer Systems | Intelligent Systems | Soft Computing | Embedded Computer Systems | Computer System Networks - Planning and Design |
| DR2 | Real-time Computer Systems | Intelligent Systems | Soft Computing | Embedded Computer Systems | Basics of Robotics |
| DR3 | Real-time Computer Systems | Internet Programming | Data Visualisation | Service Computing and Big Data | Mobile Platform Application Development |
| DR4 | Real-time Computer Systems | Internet Programming | Data Visualisation | Service Computing and Big Data | Game Development |

Semester 3 is composed of three courses, whereby students also have to undergo practical training lasting 5 weeks in a company whose area of expertise involves computer engineering.

Semester 3:

| | Course 1 | Course 2 | Course 3 | Course 4 |
|---|---|---|---|---|
| DR1 | Computer System Reliability and Diagnostics | Distributed Computer Systems | Software Quality Assurance | Practical Training in Computer Engineering |
| DR2 | Computer System Reliability and Diagnostics | Industrial Informatics | Data- based Modelling | Practical Training in Computer Engineering |

| | | | | |
|---|---|---|---|---|
| DR3 | Computer System Reliability and Diagnostics | Distributed Computer Systems | Software Quality Assurance | Practical Training in Computer Engineering |
| DR4 | Computer System Reliability and Diagnostics | Distributed Computer Systems | Internet of Things | Practical Training in Computer Engineering |

Semester 4 is identical for all three elective modules, whereby students are obliged to opt for one elective course. Furthermore, students enrol on "Master's thesis", which leads to completion of the studies.

Semester 4:

| | Course 1 | Course 2 | Course 3 | Course 4 |
|---|---|---|---|---|
| DR1<br>DR2<br>DR3<br>DR4 | Management | Project Management | Elective Course | Master's thesis |

A list of elective courses offered to all students in Semester 4:

| Courses |
|---|
| 3D Computer Graphics |
| Digital Video Technique |
| Elements of Automation |
| Intelligent Transportation Systems |
| Advanced Web Programming |
| Robot Vision |
| Sonar Computing |
| Chess and Computers |
| Green Computing |
| Elective Course – Mobility |

Note:

- In addition to the commonly offered elective courses in Semester 4, the course "Elective course-mobility" is offered and is primarily intended for recognition of courses passed at some other university in Croatia or abroad (e.g. within the Erasmus Mobility Programme). The course to be recognised has to fall into the branch being studied, but the course content differs significantly to the compulsory and optional courses offered at the study programme and can therefore not be recognised.
- In Semester 4, students are allowed to enrol in an additional elective course offered at other University constituent units. (See 4.3)

### 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 of the graduate study programme in Computer Engineering 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 Computer Engineering 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

Students can choose optional courses offered at Josip Juraj Strossmayer University of Osijek every academic year in the fourth semester.

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

Computer System Design (English)
DSP Processor Algorithms and Architecture (English)
Intelligent Systems (English)
Embedded Computer Systems (English)
Computer System Reliability and Diagnostics (English)
Sonar Computing (English)
Advanced Web Programming (English)
Basics of Robotics (English)
Soft Computing (English)

Pattern Recognition and Machine Learning (English)
Robot Vision (English)
Automation and Formal Languages (English)
Real-time Computer Systems (English)
Distributed Computer Systems (English)
Service Computing and Big Data (English)
Internet Programming (English)
Mobile Platform Application Development (English)
Internet of Things (English)
Green Computing (English)
Intelligent Transportation Systems (English)
Image Processing and Computer Vision (English)
Data Visualisation (English)
3D Computer Graphics (English)
Game Development (English)

**4.5 Describe the completion of the course of study**

A student completes the graduate university study programme in Computer Engineering by passing all the exams, preparing and defending a Master's thesis. The Master's thesis proves that a student is able to apply knowledge acquired during the studies and demonstrate that he/she is skilled to successfully solve the tasks of his/her profession suitable to the academic degree he/she has been awarded.
Details on writing and defending the Master's thesis are specified in the 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:

- a person who has lost the status of a full-time student must be allowed to complete his/her studies within a period of five years (if the student has lost his/her status during one of the study years), or ten years (if the student has lost his/her status during his/her extended study period).
- a student who has lost his/her full-time status due to interrupted studies may continue his/her studies as a full-time student, provided that the study programme has not been significantly altered.
- a student who has interrupted his/her full-time study may continue to study as a part-time student, provided that the study programme, the student has initially enrolled in, has not been significantly altered.
- a student who has lost his/her full-time status at another related university may continue his/her studies at this Faculty and he/she may have to pass differential exams.

## 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

### Graduate study programme, branch: Computer Engineering, elective block Computer Engineering

1. YEAR OF STUDY PROGRAM

**1. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DRa1-05 | DSP Algorithms and Architecture | 30 | 30 | 5 | Doc.dr.sc. MATIĆ TOMISLAV (ml.) |
| DR1-02 | Automation and Formal Languages | 30 | 30 | 6 | Prof.dr.sc. CRNKOVIĆ IVICA |
| DAR1-01 | Computer System Design | 45 | 30 | 7 | Prof.dr.sc. HOCENSKI ŽELJKO |
| DRac1-06-18 | Methods and Techniques of Software Testing | 30 | 30 | 5 | Prof.dr.sc. HOCENSKI ŽELJKO<br>Prof.dr.sc. MARTINOVIĆ GORAN |
| DRab1-02 | Control of Dynamic Systems | 45 | 30 | 7 | Prof.dr.sc. CUPEC ROBERT |

**2. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DRab2-02 | Intelligent Systems | 45 | 30 | 7 | Izv. prof. dr. sc. BLAŽEVIĆ DAMIR |
| DRa2K4I-05 | Computer System Networks - Planning and Design | 30 | 30 | 5 | Izv. prof. dr. sc. BLAŽEVIĆ DAMIR<br>Izv. prof. dr. sc. GRGIĆ KREŠIMIR |
| DR2-01 | Real-time Computer Systems | 45 | 30 | 7 | Prof.dr.sc. MARTINOVIĆ GORAN |
| DRa2-03-18 | Ubiquitous computing | 30 | 30 | 5 | Doc.dr.sc. MATIĆ TOMISLAV (ml.) |
| DARab2-04-17 | Embedded Computer Systems | 30 | 30 | 6 | Izv.prof.dr.sc. KESER TOMISLAV |

**3. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DRac3-03 | Quality Assurance of Software Support | 30 | 30 | 7 | Izv. prof. dr. sc. BLAŽEVIĆ DAMIR |
| DR3-01 | Computer System Reliability and Diagnostics | 45 | 30 | 7 | Prof.dr.sc. HOCENSKI ŽELJKO |
| DRacd3-02 | Distributed Computer Systems | 45 | 15 | 7 | Prof.dr.sc. MARTINOVIĆ GORAN |
| DR3-04 | Practical Training in Computing | 0 | 200 | 9 | Izv.prof.dr.sc. KESER TOMISLAV<br>Izv. prof. dr.sc. JOB JOSIP |

**4. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| D4-03 | Diploma Paper | 0 | 0 | 16 | |
| D4-01 | Management | 30 | 15 | 4 | Prof. dr. sc. CRNJAC-MILIĆ DOMINIKA |
| D4-02 | Project Management | 30 | 15 | 5 | Prof.dr.sc. MAJSTOROVIĆ VLADO * |
| | Elective course | | | 5 | |

**Elective courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DR4I-02 | 3D Computer Graphics - elective | 30 | 30 | 5 | Izv. prof. dr. sc. BAUMGARTNER ALFONZO |
| DR4I-11-18 | Blockchain Technology and Cryptocurrencies - elective | 30 | 30 | 5 | Izv. prof. dr. sc. LUKIĆ IVICA<br>Izv. prof. dr. sc. KÖHLER MIRKO |
| DAKR4I-01 | Digital Image Processing - elective | 30 | 45 | 5 | Prof.dr.sc. RIMAC-DRLJE SNJEŽANA |
| DR4I-10-18 | Discrete Mathematics - elective | 30 | 30 | 5 | Doc.dr.sc. RUDEC TOMISLAV |
| DER4I-05-17 | Elements of Automation - elective | 30 | 30 | 5 | Prof.dr.sc. SLIŠKOVIĆ DRAŽEN<br>Izv.prof.dr.sc. KESER TOMISLAV |

| | | | | | |
|---|---|---|---|---|---|
| DRa4I-01-19 | Digital Systems Integration - elective | 30 | 45 | 5 | Izv.prof.dr.sc. KESER TOMISLAV<br>Doc. dr. sc. ALEKSI IVAN<br>Prof.dr.sc. HOCENSKI ŽELJKO |
| DA4R4I-10 | Intelligent Transportation Systems - elective | 30 | 30 | 5 | Doc.dr.sc. BALEN JOSIP |
| DKR4I-03 | Advanced Web Programming - elective | 30 | 30 | 5 | Izv. prof. dr. sc. LUKIĆ IVICA |
| D4F-01 | German - facultative | 30 | 30 | 4 | FERČEC IVANKA |
| DI401-17 | Service Learning Projects - elective | 15 | 45 | 5 | Izv. prof. dr. sc. NENADIĆ KREŠIMIR<br>Dr.sc. MIOKOVIĆ ŽELJKA<br>Izv. prof. dr. sc. BARUKČIĆ MARINKO<br>Doc. dr. sc. ALEKSI IVAN |
| DR4I-07 | Robot Vision - elective | 30 | 30 | 5 | Prof.dr.sc. CUPEC ROBERT |
| DR4I-08 | Sonar computing - elective | 30 | 30 | 5 | Doc. dr. sc. ALEKSI IVAN |
| DKR4I-04 | Green Computing - elective | 30 | 30 | 5 | Doc.dr.sc. KRPIĆ ZDRAVKO |
| DR4I-09 | Chess and Computers - elective | 30 | 30 | 5 | Doc. dr. sc. ALEKSI IVAN |

## Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence

1. YEAR OF STUDY PROGRAM

**1. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DR1-02 | Automation and Formal Languages | 30 | 30 | 6 | Prof.dr.sc. CRNKOVIĆ IVICA |
| DAR1-01 | Computer System Design | 45 | 30 | 7 | Prof.dr.sc. HOCENSKI ŽELJKO |
| DRbd1-06-18 | Pattern Recognition and Machine Learning | 30 | 30 | 5 | Doc.dr.sc. GRBIĆ RATKO<br>Prof.dr.sc. SLIŠKOVIĆ DRAŽEN |
| DRb1-18 | Computational Geometry and Robot Vision | 30 | 30 | 5 | Prof.dr.sc. CUPEC ROBERT |
| DRab1-02 | Control of Dynamic Systems | 45 | 30 | 7 | Prof.dr.sc. CUPEC ROBERT |

**2. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DRab2-02 | Intelligent Systems | 45 | 30 | 7 | Izv. prof. dr. sc. BLAŽEVIĆ DAMIR |
| DRb2-03-18 | Soft Computing | 30 | 30 | 5 | Izv. prof. dr. sc. NYARKO EMMANUEL-KARLO |
| DRb2-05 | Basics of Robotics | 30 | 30 | 5 | Prof.dr.sc. CUPEC ROBERT |
| DR2-01 | Real-time Computer Systems | 45 | 30 | 7 | Prof.dr.sc. MARTINOVIĆ GORAN |
| DARab2-04-17 | Embedded Computer Systems | 30 | 30 | 6 | Izv.prof.dr.sc. KESER TOMISLAV |

## 2. YEAR OF STUDY PROGRAM

**3. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DRb3Ec1-03 | Industrial Informatics | 30 | 45 | 7 | Prof.dr.sc. SLIŠKOVIĆ DRAŽEN |
| DRb3-03 | Data based modeling | 30 | 30 | 7 | Prof.dr.sc. SLIŠKOVIĆ DRAŽEN |
| DR3-01 | Computer System Reliability and Diagnostics | 45 | 30 | 7 | Prof.dr.sc. HOCENSKI ŽELJKO |
| DR3-04 | Practical Training in Computing | 0 | 200 | 9 | Izv.prof.dr.sc. KESER TOMISLAV<br>Izv. prof. dr.sc. JOB JOSIP |

**4. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| D4-03 | Diploma Paper | 0 | 0 | 16 | |
| D4-01 | Management | 30 | 15 | 4 | Prof. dr. sc. CRNJAC-MILIĆ DOMINIKA |
| D4-02 | Project Management | 30 | 15 | 5 | Prof.dr.sc. MAJSTOROVIĆ VLADO * |
| | Elective course | | | 5 | |

**Elective courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DR4I-02 | 3D Computer Graphics - elective | 30 | 30 | 5 | Izv. prof. dr. sc. BAUMGARTNER ALFONZO |
| DR4I-11-18 | Blockchain Technology and Cryptocurrencies - elective | 30 | 30 | 5 | Izv. prof. dr. sc. LUKIĆ IVICA<br>Izv. prof. dr. sc. KÖHLER MIRKO |
| DAKR4I-01 | Digital Image Processing - elective | 30 | 45 | 5 | Prof.dr.sc. RIMAC-DRLJE SNJEŽANA |
| DR4I-10-18 | Discrete Mathematics - elective | 30 | 30 | 5 | Doc.dr.sc. RUDEC TOMISLAV |
| DER4I-05-17 | Elements of Automation - elective | 30 | 30 | 5 | Prof.dr.sc. SLIŠKOVIĆ DRAŽEN<br>Izv.prof.dr.sc. KESER TOMISLAV |
| DA4R4I-10 | Intelligent Transportation Systems - elective | 30 | 30 | 5 | Doc.dr.sc. BALEN JOSIP |
| DKR4I-03 | Advanced Web Programming - elective | 30 | 30 | 5 | Izv. prof. dr. sc. LUKIĆ IVICA |
| D4F-01 | German - facultative | 30 | 30 | 4 | FERČEC IVANKA |
| DRb4I-01-19 | Programming Robots - elective | 30 | 30 | 5 | Izv. prof. dr. sc. . FILKO DAMIR |
| DI401-17 | Service Learning Projects - elective | 15 | 45 | 5 | Izv. prof. dr. sc. NENADIĆ KREŠIMIR<br>Dr.sc. MIOKOVIĆ ŽELJKA<br>Izv. prof. dr. sc. BARUKČIĆ MARINKO<br>Doc. dr. sc. ALEKSI IVAN |
| DR4I-07 | Robot Vision - elective | 30 | 30 | 5 | Prof.dr.sc. CUPEC ROBERT |
| DR4I-08 | Sonar computing - elective | 30 | 30 | 5 | Doc. dr. sc. ALEKSI IVAN |
| DKR4I-04 | Green Computing - elective | 30 | 30 | 5 | Doc.dr.sc. KRPIĆ ZDRAVKO |
| DR4I-09 | Chess and Computers - elective | 30 | 30 | 5 | Doc. dr. sc. ALEKSI IVAN |

## Graduate study programme, branch: Computer Engineering, elective block Software Engineering

### 1. YEAR OF STUDY PROGRAM

**1. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DR1-02 | Automation and Formal Languages | 30 | 30 | 6 | Prof.dr.sc. CRNKOVIĆ IVICA |

| | | | | | |
|---|---|---|---|---|---|
| DAR1-01 | Computer System Design | 45 | 30 | 7 | Prof.dr.sc. HOCENSKI ŽELJKO |
| DRac1-06-18 | Methods and Techniques of Software Testing | 30 | 30 | 5 | Prof.dr.sc. HOCENSKI ŽELJKO<br>Prof.dr.sc. MARTINOVIĆ GORAN |
| DRc1-05 | Software System Design and Modelling | 30 | 30 | 6 | Prof.dr.sc. CRNKOVIĆ IVICA |
| DRcd1-06-18 | Service Computing and Big Data | 30 | 30 | 6 | Prof.dr.sc. MARTINOVIĆ GORAN |

**2. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DRcKb2-05 | Mobile platform application development | 30 | 45 | 5 | Doc.dr.sc. BALEN JOSIP |
| DR2-01 | Real-time Computer Systems | 45 | 30 | 7 | Prof.dr.sc. MARTINOVIĆ GORAN |
| DRcd1-04 | System Programming | 45 | 15 | 6 | Izv. prof. dr. sc. BAUMGARTNER ALFONZO |
| DRcd2-03 | Data visualization | 30 | 30 | 5 | Izv. prof. dr.sc. JOB JOSIP |
| DRcdKb2-02-18 | Web Programming | 45 | 30 | 7 | Izv. prof. dr. sc. NENADIĆ KREŠIMIR |

## 2. YEAR OF STUDY PROGRAM

**3. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DRac3-03 | Quality Assurance of Software Support | 30 | 30 | 7 | Izv. prof. dr. sc. BLAŽEVIĆ DAMIR |
| DR3-01 | Computer System Reliability and Diagnostics | 45 | 30 | 7 | Prof.dr.sc. HOCENSKI ŽELJKO |
| DRacd3-02 | Distributed Computer Systems | 45 | 15 | 7 | Prof.dr.sc. MARTINOVIĆ GORAN |
| DR3-04 | Practical Training in Computing | 0 | 200 | 9 | Izv.prof.dr.sc. KESER TOMISLAV<br>Izv. prof. dr.sc. JOB JOSIP |

**4. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| D4-03 | Diploma Paper | 0 | 0 | 16 | |
| D4-01 | Management | 30 | 15 | 4 | Prof. dr. sc. CRNJAC-MILIĆ DOMINIKA |
| D4-02 | Project Management | 30 | 15 | 5 | Prof.dr.sc. MAJSTOROVIĆ VLADO * |
| | Elective course | | | 5 | |

**Elective courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DR4I-02 | 3D Computer Graphics - elective | 30 | 30 | 5 | Izv. prof. dr. sc. BAUMGARTNER ALFONZO |
| DR4I-11-18 | Blockchain Technology and Cryptocurrencies - elective | 30 | 30 | 5 | Izv. prof. dr. sc. LUKIĆ IVICA<br>Izv. prof. dr. sc. KÖHLER MIRKO |
| DAKR4I-01 | Digital Image Processing - elective | 30 | 45 | 5 | Prof.dr.sc. RIMAC-DRLJE SNJEŽANA |
| DR4I-10-18 | Discrete Mathematics - elective | 30 | 30 | 5 | Doc.dr.sc. RUDEC TOMISLAV |
| DER4I-05-17 | Elements of Automation - elective | 30 | 30 | 5 | Prof.dr.sc. SLIŠKOVIĆ DRAŽEN<br>Izv.prof.dr.sc. KESER TOMISLAV |
| DA4R4I-10 | Intelligent Transportation Systems - elective | 30 | 30 | 5 | Doc.dr.sc. BALEN JOSIP |
| DKR4I-03 | Advanced Web Programming - elective | 30 | 30 | 5 | Izv. prof. dr. sc. LUKIĆ IVICA |
| D4F-01 | German - facultative | 30 | 30 | 4 | FERČEC IVANKA |
| DI401-17 | Service Learning Projects - elective | 15 | 45 | 5 | Izv. prof. dr. sc. NENADIĆ KREŠIMIR<br>Dr.sc. MIOKOVIĆ ŽELJKA<br>Izv. prof. dr. sc. BARUKČIĆ MARINKO<br>Doc. dr. sc. ALEKSI IVAN |
| DR4I-07 | Robot Vision - elective | 30 | 30 | 5 | Prof.dr.sc. CUPEC ROBERT |
| DR4I-08 | Sonar computing - elective | 30 | 30 | 5 | Doc. dr. sc. ALEKSI IVAN |
| DKR4I-04 | Green Computing - elective | 30 | 30 | 5 | Doc.dr.sc. KRPIĆ ZDRAVKO |
| DR4I-09 | Chess and Computers - elective | 30 | 30 | 5 | Doc. dr. sc. ALEKSI IVAN |

## Graduate study programme, branch: Computer Engineering, elective block Information and data science

### 1. YEAR OF STUDY PROGRAM

**1. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DR1-02 | Automation and Formal Languages | 30 | 30 | 6 | Prof.dr.sc. CRNKOVIĆ IVICA |
| DAR1-01 | Computer System Design | 45 | 30 | 7 | Prof.dr.sc. HOCENSKI ŽELJKO |
| DRd1-05 | Image Processing and Computer Vision | 45 | 30 | 6 | |
| DRbd1-06-18 | Pattern Recognition and Machine Learning | 30 | 30 | 5 | Doc.dr.sc. GRBIĆ RATKO<br>Prof.dr.sc. SLIŠKOVIĆ DRAŽEN |
| DRcd1-06-18 | Service Computing and Big Data | 30 | 30 | 6 | Prof.dr.sc. MARTINOVIĆ GORAN |

**2. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DRd2-05 | Game Development | 30 | 30 | 5 | Doc.dr.sc. LIVADA ČASLAV |
| DR2-01 | Real-time Computer Systems | 45 | 30 | 7 | Prof.dr.sc. MARTINOVIĆ GORAN |
| DRcd1-04 | System Programming | 45 | 15 | 6 | Izv. prof. dr. sc. BAUMGARTNER ALFONZO |
| DRcd2-03 | Data visualization | 30 | 30 | 5 | Izv. prof. dr.sc. JOB JOSIP |
| DRcdKb2-02-18 | Web Programming | 45 | 30 | 7 | Izv. prof. dr. sc. NENADIĆ KREŠIMIR |

### 2. YEAR OF STUDY PROGRAM

**3. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DRdKb3-03 | Internet of Things | 30 | 30 | 7 | Izv. prof. dr.sc. JOB JOSIP<br>Doc.dr.sc. GRBIĆ RATKO |

| | | | | | |
|---|---|---|---|---|---|
| DR3-01 | Computer System Reliability and Diagnostics | 45 | 30 | 7 | Prof.dr.sc. HOCENSKI ŽELJKO |
| DRacd3-02 | Distributed Computer Systems | 45 | 15 | 7 | Prof.dr.sc. MARTINOVIĆ GORAN |
| DR3-04 | Practical Training in Computing | 0 | 200 | 9 | Izv.prof.dr.sc. KESER TOMISLAV<br>Izv. prof. dr.sc. JOB JOSIP |

**4. semester – Mandatory courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| D4-03 | Diploma Paper | 0 | 0 | 16 | |
| D4-01 | Management | 30 | 15 | 4 | Prof. dr. sc. CRNJAC-MILIĆ DOMINIKA |
| D4-02 | Project Management | 30 | 15 | 5 | Prof.dr.sc. MAJSTOROVIĆ VLADO * |
| | Elective course | | | 5 | |

**Elective courses**

| Code | Course | L workload | E workload | ECTS | Teacher |
|---|---|---|---|---|---|
| DR4I-02 | 3D Computer Graphics - elective | 30 | 30 | 5 | Izv. prof. dr. sc. BAUMGARTNER ALFONZO |
| DR4I-11-18 | Blockchain Technology and Cryptocurrencies - elective | 30 | 30 | 5 | Izv. prof. dr. sc. LUKIĆ IVICA<br>Izv. prof. dr. sc. KÖHLER MIRKO |
| DAKR4I-01 | Digital Image Processing - elective | 30 | 45 | 5 | Prof.dr.sc. RIMAC-DRLJE SNJEŽANA |
| DR4I-10-18 | Discrete Mathematics - elective | 30 | 30 | 5 | Doc.dr.sc. RUDEC TOMISLAV |
| DER4I-05-17 | Elements of Automation - elective | 30 | 30 | 5 | Prof.dr.sc. SLIŠKOVIĆ DRAŽEN<br>Izv.prof.dr.sc. KESER TOMISLAV |
| DA4R4I-10 | Intelligent Transportation Systems - elective | 30 | 30 | 5 | Doc.dr.sc. BALEN JOSIP |
| DKR4I-03 | Advanced Web Programming - elective | 30 | 30 | 5 | Izv. prof. dr. sc. LUKIĆ IVICA |
| D4F-01 | German - facultative | 30 | 30 | 4 | FERČEC IVANKA |
| DI401-17 | Service Learning Projects - elective | 15 | 45 | 5 | Izv. prof. dr. sc. NENADIĆ KREŠIMIR<br>Dr.sc. MIOKOVIĆ ŽELJKA<br>Izv. prof. dr. sc. BARUKČIĆ MARINKO<br>Doc. dr. sc. ALEKSI IVAN |

| | | | | | |
|---|---|---|---|---|---|
| DR4I-07 | Robot Vision - elective | 30 | 30 | 5 | Prof.dr.sc. CUPEC ROBERT |
| DR4I-08 | Sonar computing - elective | 30 | 30 | 5 | Doc. dr. sc. ALEKSI IVAN |
| DKR4I-04 | Green Computing - elective | 30 | 30 | 5 | Doc.dr.sc. KRPIĆ ZDRAVKO |
| DR4I-09 | Chess and Computers - elective | 30 | 30 | 5 | Doc. dr. sc. ALEKSI IVAN |

## 7.5. Description and general information of each subject

| General information | | |
|---|---|---|
| Lecturer | Izv. prof. dr. sc. BAUMGARTNER ALFONZO | |
| Course name | DR4I-02 3D Computer Graphics | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Show students the principles of geometric modelling, 3D graphics and computer animation. Introduce matrix representation of geometric transformations and projections into 3D, and application of OpenGL and BMRT (virtual scene, coordinate systems, camera model, z-mail, charting, shading) programme interfaces. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the second year of the study programme | |
| *1.3. Learning outcomes* | |
| 1.define and describe the concepts of geometric modeling, 3D graphics and computer animation<br>2.interpret the methods of modelling 3D objects and making their realistic view<br>3.describe lightning, transparency, texture and shading models<br>4.interpret the basic principles of interpolation, hierarchical structures needed to apply the virtual display process<br>5.apply mathematical and physical knowledge to computer graphic problems and evaluate results<br>6.connect the acquired knowledge to create a computer graphics algorithm and interpret the result | |
| *1.4. Course content* | |
| Students will be introduced to the theoretical and practical fundamentals of applying the principles of geometric modelling, 3D graphics and computer animation. The concepts and techniques of representing three-dimensional objects and realising their realistic presentation are elaborated. Understand the basic principles of interpolation and hierarchical structures needed to apply the visualisation process. Practical computer programming skills. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 0 | 10 |
| Practice – problem solving | 1 | 5,6 | Midterm exam | Evaluation of (written) exercises | 10 | 20 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 1,2,3,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 10 | 20 |
| Oral exam | 1 | 1,2,3,4,5,6 | Oral exam | Assessment of student's answers | 25 | 50 |

*1.10. Obligatory literature*

1 Pandžić, I.S. Virtualna okruženja Udžbenici Sveučilišta u Zagrebu. Zagreb: Element, 2004.

*1.11. Recommended additional literature*

1 J. Neider, T. Davis, M. Woo OpenGL Programming Guide Addison-Wesley, 1999.
2 A. S. Glassner Principles of Digital Image Synthesis Morgan Kaufman, San Francisco, 1996.
3 A. S. Glassner An Introduction to Ray-Tracing Morgan Kaufman, San Francisco, 1989.
4 A. H. Watt 3D Computer Graphics Addison-Wesley, 2000.
5 P.Shirley, M. Ashikhmin, S. Marschner, Fundamentals of Computer Graphics CRC Press, London, 2009.
6 J. D. Foley, J. F. Huges, A. van Dam, M. McGuire, D. F. Sklar, S. K. Feiner, K. Akeley Computer Graphics: Principles and Practice Addison-Wesley, Willard, 2013.

*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. MATIĆ TOMISLAV (ml.) | |
| Course name | DRa1-05 DSP Algorithms and Architecture | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory) | |
| Course status | Mandatory | |
| Year of study | 1 | |
| 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 theoretical, practical and simulation knowledge in the field of DSP processors architecture and algorithms. | |
| *1.2. Conditions for enrollment* | |
| The necessary requirements to enrol in the second year of the studies. | |
| *1.3. Learning outcomes* | |
| 1.have insight into formal languages<br>2.outline and explain architecture of a DSP processor<br>3.distinguish and demonstrate operating principles of a particular digital signal processor functional unit<br>4.apply and test different software and simulation tools for digital signal processor programming<br>5.implement different software algorithms in the assembler and C programming language<br>6.implement and demonstrate the developed programme solution on the DSP system | |
| *1.4. Course content* | |
| Introduction. DSP processor requirements for FIR, IIR filters and FFT. Processor architecture: RISC, DSP, data path. MAC unit, ALU unit, memory architecture, buses, addressing, instruction set, data path, fixed-point, floating-point, complex arithmetic, vector arithmetic, parallel data processing. C programming language, assembler, development tools and DSP programming, real-time execution. DSP processor application examples: audio processing, image processing, computer vision, video coding and decoding. | |
| *1.5. Teaching methods* | Lecture<br>Auditory exercises<br>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 | 2 | 1,2,3,4,5,6 | Lectures, Auditory exercises, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 2 | 5 |
| Practice – problem solving | 1 | 2,3,5,6 | Midterm exam | Evaluation of (written) exercises | 18 | 35 |
| 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 | 11 | 30 |
| Oral exam | 1 | 1,2,3,4 | Oral exam | Assessment of student's answers | 15 | 30 |

*1.10. Obligatory literature*

1 Rulph, Chassaing; S. Donald, Reay Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK, 2nd Edition John Wiley & Sons, 2008., New Jersey.

*1.11. Recommended additional literature*

1 F. Mayer-Lindenberg Dedicated Digital Processors, Methods in Hardware/Software System Design; 1. Edition John Wiley & Sons 2004.
2 D. Markovic, R. W. Brodersen DSP Architecture Design Essentials (Electrical Engineering Essentials) Springer 2012.
3 S. Mitra Digital Signal Processing with Student September 2010, McGraw-Hill Science/Engineering/Math, 2010.
4 P. Pirsch Architectures for Digital Signal Processing John Wiley & Sons, 1998.
5 P. Lapsley, J. Bier, A. Shoham, E. A. Lee DSP Processor Fundamentals, Architectures and Wiley-IEEE Press, 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 | CRNKOVIĆ IVICA | |
| Course name | DR1-02 Automation and Formal Languages | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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* | |
| Present the principles of formal languages and automata. Give insights into formal languages, Turing machine and basics in computation. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.have insight into formal languages<br>2.understand regular languages, grammars and expressions<br>3.understand context-free languages, grammars and automata<br>4.have insight into a Turing machine and basics of the theory of computation | |
| *1.4. Course content* | |
| Context-free languages. Context sensitive languages. Derivation tree. Grammars and machines. Chomsky hierarchy, closure properties, regular and finite languages. Push-down automaton and context free grammars. Parsing. Turing machine and language theory. Fixed point principle and language theory. Inductions. Semantic types: operational, formal and axiomatic. Computability. Problem of programme finiteness and undecidability. Goedel theorem. Church - Turing thesis. | |
| *1.5. Teaching methods* | Lecture<br>Auditory exercises<br>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 | 2 | 1,2,3,4 | Lectures, Auditory exercises, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 5 | 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 | 1 | 1,2,3,4 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 15 | 30 |
| Oral exam | 2 | 1,2,3,4 | Oral exam | Assessment of student's answers | 20 | 40 |

*1.10. Obligatory literature*

1 Linz, Peter An Introduction to Formal Languages and Automata Jones & Bartlett, 5th edition, 2012
2 Srbljić, S. JEZIČNI PROCESORI 1: Uvod u teoriju formalnih jezika, automata i gramatika Udžbenik Sveučilišta u Zagrebu. Zagreb : Element, 2000.

*1.11. Recommended additional literature*

1 S. Srbljić Uvod u teoriju računarstva Element, Zagreb, 2007.
2 S. Srbljić Prevođenje programskih jezika Element, Zagreb, 2007.
3 Moll R., Arbib M.A. i Kfoury A.J. An introduction to formal language theory Springer Verlag 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. LUKIĆ IVICA, Izv. prof. dr. sc. KÖHLER MIRKO | |
| Course name | DR4I-11-18 Blockchain Technology and Cryptocurrencies | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Introduce students to the blockchain technology and principles which they are based on (ledger). Familiarise them with the benefits of P2P networks and distributed ledger. Explain different approaches to blockchain creation and present advantages and disadvantages of the most common approaches. Give an overview of the hash function. Present the differences between blockchain and cryptocurrencies, public and private chains, and blockchain technology and directed acyclic graph (DAG). Teach the basics of different algorithms for cryptocurrencies mining. Provide insights on the application of blockchain technology and its effect on the future of private and public sectors. | |
| *1.2. Conditions for enrollment* | |
| Requirements for the enrolment in the graduate university study programme | |
| *1.3. Learning outcomes* | |
| 1.explain the reasons for using the blockchain technology<br>2.describe the benefits of new technology and their applications<br>3.analyse existing technology applications and understand their advantages and disadvantages<br>4.use already existing blockchains<br>5.create one's own blockchain<br>6.create new software solutions for specific problems by applying acquired knowledge | |
| *1.4. Course content* | |
| An introduction to the blockchain technology. Applications of the blockchain technology in the public and private sector. A comprehensive approach to the technology through business solutions and cryptocurrencies. The concept of the main book and the advantage of its combination with P2P network architecture. An introduction to encrypting information and using hash functions. Definition of decentralization; advantages and disadvantages of decentralised systems. Anonymity in blockchain. Cryptocurrencies as the most commonly application of blockchain. Bitcoin and other alternative cryptocurrencies. Different types of consensus, the most common algorithms for cryptocurrencies mining, the future of blockchain, cryptocurrencies and other technology of distributed main books. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1.5 | 1,2,3,4,5 | Lectures, Laboratory exercises | | 0 | 0 |
| 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 | 1 | 1,2,3,5,6 | Oral exam | Assessment of student's answers | 20 | 40 |
| Homeworks / Seminars | 1.5 | 1,2,3,4,5,6 | Solving homework or writing seminar papers | Evaluation of (written) exercises | 20 | 40 |

*1.10. Obligatory literature*

1 M. Swan Blockchain Blueprint for a New Economy O Reilly Media; January 2015
2 A. M. Antonopoulos Mastering Bitcoin: Programming the Open Blockchain
3 A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder; Bitcoin and Cryptocurrency Technologies Princeton University; textbook; 2016.
4 Stallings, M. Cryptography and Network Security - Principles and Practice (7th edition) Boston: Pearson, 2016.

*1.11. Recommended additional literature*

1 Developer Documentation - https://bitcoin.org/en/developer-guide
2 Satoshi Nakamoto Bitcoin: A Peer-to-Peer Electronic Cash System - white paper

*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: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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<br>2.analyse the application of DCT, motion estimation and compensation as well as evaluate the application of different video coding standards<br>3.distinguish source and channel coding methods as well as types of modulation for DVB-T and DVB-T2<br>4.compare different methods of content protection as well as conditional access in a digital television<br>5.develop software support for a digital television receiver, including protocol usage, as well as download and use of data from the transport stream<br>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<br>Laboratory exercises<br>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 | 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: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (mandatory) | |
| Course status | Mandatory | |
| Year of study | 2 | |
| ECTS credits and teaching methods | ECTS credits | 16 |
| | Workload (L+(AE+LE+CE)+S) | 0+(0+0+0)+0 |

| 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. By guiding the mentor, help the student solve the task. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the second year of the study programme | |
| *1.3. Learning outcomes* | |
| 1.depends on the subject of graduate thesis<br>2.depends on the subject of graduate thesis<br>3.depends on the subject of graduate thesis<br>4.depends on the subject of graduate thesis | |
| *1.4. Course content* | |
| Depends on the topic of the Masters thesis. | |
| *1.5. Teaching methods* | |
| *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 | 3.7 | 1 | | Attendance register. Mandatory attendance percentage is: 25%. | 5 | 10 |
| Practice – problem solving | 4 | 2 | Midterm exam | Evaluation of (written) exercises | 20 | 40 |

*1.10. Obligatory literature*

1 Ovisi o temi diplomskog rada.

*1.11. Recommended additional literature*

1 Ovisi o temi diplomskog rada.

*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 | Doc.dr.sc. RUDEC TOMISLAV | |
| Course name | DR4I-10-18 Discrete Mathematics | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (elective) | |
| Course status | Elective | |
| Year of study | 2 | |
| ECTS credits and teaching methods | ECTS credits | 5 |
| | Workload (L+(AE+LE+CE)+S) | 30+(30+0+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Teach students the concepts and simple examples of mathematical logic, set theory, and number theory. Prepare students for lifelong learning and use of mathematical structures, relationships and operations as tools in application. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.create KNF and DNF and simplify them<br>2.create a model for solving the expression equation<br>3.design the wanted set based on the requirements from the basis of the set theory<br>4.create a model for constructing a task solution from the set theory<br>5.create a path for tasks solving in the basics of the number theory | |
| *1.4. Course content* | |
| Mathematical logic. Introduction to logic. Propositional logic. Propositional logic alphabet. Semantics and syntax. Logical operations. Truth Tables. Tautology. Conjunctive and disjunctive normal form. Formulas Equations. Natural deduction. The basics of set theory. Set operations. Venn Diagrams. Binary Relation. Equivalence Relation. Partition of the set. Order Relations. The basics of the number theory. Integers. Divisiblity and prime numbers. Congruences. Eulers function. Eulers theorem and the Fermats little theorem. Introduction to Diophantine Equations. | |
| *1.5. Teaching methods* | Lecture<br>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 | 2 | 1,2,3,4 | Lectures, Auditory exercises | | 0 | 0 |
| Practice – problem solving | 1.3 | 1,2,3,5 | Midterm exam | Evaluation of (written) exercises | 25 | 50 |
| Oral exam | 1 | 1,2,4,5 | Oral exam | Assessment of student's answers | 15 | 30 |
| Tasks set in teaching and tasks for domestic work. | 0.7 | 2,3,4,5 | Homework | Discussion upon presentation | 0 | 20 |

*1.10. Obligatory literature*

1 Žubrinić, Darko Diskretna matematika Zagreb:Element, 2002.
2 Anderson, I. A first Course in Discrete Mathematics Springer Verlag, 2001.

*1.11. Recommended additional literature*

1 Stanford Encyclopedia of Phylosophy, Classical Logic e- skripta
2 Mladen Vuković Logika e-skripta
3 M. Vuković i V. Čačić Teorija skupova e-skripta (PMF Zagreb)

*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 | DAR1-01 Computer System Design | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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<br>2.explain and compare parts of a computer system<br>3.compare and test the operating mode of various simple and complex computer systems<br>4.specify and design simple processor systems with peripheral units<br>5.apply and test simple processor systems on development boards<br>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<br>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 | 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 | 1 | 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 | 1 | 1,2,3 | Oral exam | Assessment of student's answers | 15 | 30 |
| Solving Tasks 1 | 1.5 | 1,2,3,4 | Revision exam (1/2 of the written exam) | Evaluation of exercises | 12 | 25 |
| Solving Tasks 2 | 1.5 | 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, 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 | Prof.dr.sc. SLIŠKOVIĆ DRAŽEN, Izv.prof.dr.sc. KESER TOMISLAV | |
| Course name | DER4I-05-17 Elements of Automation | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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+0)+0 |

| 1. Course description |
|---|
| *1.1. Goals* |
| Present the basic principles of automation system and process management mechanisms. Familiarise students with the basic building blocks of a control circuit, teach them to identify and define the tasks of particular parts of the control circuit, and to select and define the requirements to the needs of the managed process. Show them the types and explain the purpose of measuring and actuating control parts, as well as their technical-technological characteristics. Explain to them the physical principles of measuring and generating process variables, processing of measurement signals and reduction of measurement uncertainty and interference. Present the types and topologies of industrial communication networks. Familiarise them with types and applications of industrial computers and embedded computer systems of special purpose and functionality. |
| *1.2. Conditions for enrollment* |
| Requirements met for enrolling in the second year of the study programme |
| *1.3. Learning outcomes* |
| 1.to define the role of measuring and actuator devices and other equipment for the realization of the automated control system<br>2.to select the type and characteristics of the measuring and actuator devices in accordance with the requirements of the specific control task<br>3.evaluate and select industrial computer components for process control and supervision needs<br>4.evaluate and select a suitable drive for an electric motor and connect it with a process computer<br>5.make a simple user programme for a selected process computer<br>6.design a simple control system based on embedded or industrial computer systems |
| *1.4. Course content* |
| Measurement of process variables: distance, position, angle of rotation, thickness, rotation speed, force, torque, level, pressure, flow, temperature, pH value and other process sizes. Technologies for transferring measurement signals. Types of interference and their sources. Measurement errors. Signal processing. Measuring devices in automatic control systems. Executing devices: DC, AC and AC motors, pneumatic, electropneumatic, hydraulic and electrohydraulic devices, pumps, compressors and valves. Thyristor and transistor inverters. Static and dynamic characteristics of measuring and control devices. Intelligent measuring and executive devices. Input and output units and interfaces in measurement and control |

devices. Process computers, design and programming. Industrial communication and management organisation. Built-in computer systems.

| | |
|---|---|
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3,4,5,6 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 40%. | 2 | 5 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 0.5 | 3,4,5,6 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 15 | 30 |
| Oral exam | 0.2 | 1,2,3,4 | Oral exam | Assessment of student's answers | 15 | 30 |
| Written exam | 1.8 | 1,2,3,4,5,6 | Presenting a seminar paper | Project review and evaluation | 15 | 30 |
| Project presentation | 0.5 | 2,3,4,6 | Course report. | Project evaluation | 2 | 5 |

*1.10. Obligatory literature*

1 Clarence W. de Silva Sensors and Actuators: Engineering System Instrumentation, Second Edition CRC Press 2015, ISBN 9781466506817
2 J. Tomac Osnove automatske regulacije - Elementi automatike - predavanja ETF, Osijek, 2008.

*1.11. Recommended additional literature*

1 M. Jadrić, B. Frančić Dinamika električnih strojeva Sveučilište u Splitu, Graphis Zagreb, 1995.
2 B. K. Bose Modern Power Electronics and AC Drives Prentice Hall, Upper Saddle River, USA, 2002.
3 A. Parr Hydraulics and Pneumatics - A technicians and engineers guide, second edition Elsevier Ltd, Velika Britanija, 1998.
4 Z. Kovačić, S. Bogdan Elementi automatizacije procesa - predavanja FER, Zagreb.

*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. SLIŠKOVIĆ DRAŽEN | |
| Course name | DRb3Ec1-03 Industrial Informatics | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (mandatory) | |
| Course status | Mandatory | |
| Year of study | 2 | |
| ECTS credits and teaching methods | ECTS credits | 7 |
| | Workload (L+(AE+LE+CE)+S) | 30+(15+30+0)+0 |

| 1. Course description |
|---|
| *1.1. Goals* |
| Familiarise students with production system control tasks, and the implementation method of an automatic process control system, starting from the technical process level, over control systems to supervisory systems and the production process as a whole. Present the application of PLCs, SCADA systems and industrial communication systems, which form the basis for a practical implementation of automatic control of various processes. |
| *1.2. Conditions for enrollment* |
| Requirements met for enrolling in the second year of the study programme |
| *1.3. Learning outcomes* |
| 1.describe the control methods of complex technical (production) systems, and explain informatization and automation of production systems<br>2.describe the structure and working principles of a process computer and its realisation as a programmable logic controller<br>3.select PLC configuration and write controlling/user programme for simple and complex exercises<br>4.explain the advantages and disadvantages of (de)centralisation in the implementation of a process automation system<br>5.describe the role and structure of SCADA and its main interfaces<br>6.define the requirements for the communication system at different control levels, and choose a suitable communcation method for a specific purpose<br>7.establish communication (with several communication standards) using Simatic equipment |
| *1.4. Course content* |
| Manufacturing system and an industrial plant. Control processes and stratification of control assignments. Informatisation and automatisation of a manufacturing system. Basic structure of automatic control processes. Practical examples. Measurement and process value displaying system. Automatic control system. Digital realisation of a controller. Process computer and a programmable logic controller. Linking a process computer with a process. Control unit â€“ a central unit for an automatic control process. Structures of a processing unit: central and non-central, hierarchical and distributive. Regulatory unit â€“ a subsystem for communication of an operator-manufacturing system and a process database. Structural regulatory units and the ways of providing services of a current automatisation system. Process and regulatory unit equipment. Communication systems for industrial application. Portable technologies/general purpose standards as the basis for the majority of industrial communication standards. Communication technologies on the level of fields and higher controlling levels. Specialised networks for programmable logic controllers. Software support in automatisation systems. User programming tools. Examples of systems for controlling and automatisation of manufacturing processes and supervision of an automatic manufacturing process. Information related to designing and maintaining automatisation systems. |

| | |
|---|---|
| *1.5. Teaching methods* | Lecture<br>Auditory exercises<br>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 | 2.5 | 1,2,3,4,5,6,7 | Lectures, Auditory exercises, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 2 | 5 |
| Practice – problem solving | 1.3 | 3,4,5,6 | Midterm exam | Evaluation of (written) exercises | 15 | 30 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1.7 | 3,5,6,7 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 12 | 30 |
| Oral exam | 1.5 | 1,2,4,5,6 | Oral exam | Assessment of student's answers | 18 | 35 |

*1.10. Obligatory literature*

1 Slišković, D. Procesna automatizacija – predavanja ETFOS, Osijek, 2009.
2 Perić, N. Automatizacija postrojenja i procesa - predavanja FER, Zagreb, 2000.

*1.11. Recommended additional literature*

1 Smiljanić, G. Računala i procesi Školska knjiga, Zagreb, 1991.
2 Jović, F. Kompjutersko vođenje procesa Zveza organizacij za tehničko kulturo Slovenije, Ljubljana, 1988.
3 Crispin, A. J. Programmable Logic Controllers and their Engineering Applications McGraw-Hill Publishing Company, 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 | Izv.prof.dr.sc. KESER TOMISLAV, doc. dr. sc. ALEKSI IVAN | |
| Course name | DRa4I-01-19 Digital Systems Integration | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (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+30)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| The aim of this course is to introduce and train students to the procedures and tasks of designing, building, integration and functional verification of complex digital and computer systems. Also, to demonstrate and getting familiar with the basic principles of designing complex digital systems through the use of development and simulation tools for integration. Get acquainted with the design principles of the design of printed circuits and the procedures in their production. To make introduction with the norms used to design digital systems. To demonstrate and learn the principles of good practice in the design of printed circuit board in accordance with the rules of electromagnetic compatibility and layout of flat circuitry. To apply recommendations and standards in the design and integration of digital systems. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the second year of the study programme | |
| *1.3. Learning outcomes* | |
| 1. Explain the basic concepts and identify developmental stages in the integration of complex digital systems.<br>2. Distinguish the needs and specifics of design between planar and 3D structured circuits.<br>3. Identify and model requirements in proper modeling of planarly structured circuits.<br>4. Design planarly structured complex circuits according to the instructions and ruls of electro-magnetic compatibility (EMC).<br>5. Apply development tools and insights into EMC challenges in the proper structuring of planar circuits.<br>6. Create and integrate a more complex plane-dimensioned circuit into a functional unity.<br>7. Apply recommendations and standards in the design and integration of digital systems. | |
| *1.4. Course content* | |
| Basic concepts and tasks of design and building complex digital systems. Basic concepts and tasks of integration and functional testing of digital and computer systems. Design and functional simulation of structural diagrams using development tools Mentor Graphics and Altium Designer. Design of planarly dimensioned complex circuits. Basics of flat structured design. Elements of electromagnetic compatibility in the design of planar structures. Good practices in the use of design and simulation tools for the purpose of integration of complex digital and computer systems. | |
| *1.5. Teaching methods* | Lecture<br>Laboratory exercises<br>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 | 1,2,3,4,5,6 | Lectures, Laboratory exercises, Design exercises | | 7 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 0.5 | 2,3,4 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 10 | 10 |
| Oral exam | 0.5 | 1,2,3,4,5,6,7 | Oral exam | Assessment of student's answers | 0 | 20 |
| Problem-solving related to design exercises | 1 | 3,4,5,6 | Design exercises | Evaluation of problem solving exercises | 10 | 20 |
| Solving project tasks | 1 | 1,2,3,4,5,6,7 | Solving project tasks | Evaluation of a project assignment, presentation grading | 20 | 40 |

*1.10. Obligatory literature*

1 Christopher T. Robertson Printed Circuit Board Designers Reference: Basics Prentice Hall Professional, 2004.
2 Eric Bogatin Signal and Power Integrity, Simplified Prentice Hall, 2018.
3 R. Magjarević, Z. Stare, M. Cifrek, H. Džapo, M. Ivančić, I. Lacković Projektiranje tiskanih veza Udžbenik Sveučilišta u Zagrebu.

*1.11. Recommended additional literature*

1 Bruce R. Archambeault, James Drewniak PCB Design for Real-World EMI Control Springer Science & Business Media, 2002.
2 David A. Weston Electromagnetic Compatibility: Methods, Analysis, Circuits, and Measurement CRC Press 2016.
3 Douglas Brooks Signal Integrity Issues and Printed Circuit Board Design Prentice Hall Professional, 2003.
4 Leonard Marks, James Caterina Printed Circuit Assembly Design McGraw Hill Professional, 2000.
5 Hanqiao Zhang, Steven Krooswyk, Jeffrey Ou High Speed Digital Design: Design of High Speed Interconnects and Signaling Elsevier Science, 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 | Izv. prof. dr. sc. BLAŽEVIĆ DAMIR | |
| Course name | DRab2-02 Intelligent Systems | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (mandatory) | |
| Course status | Mandatory | |
| Year of study | 1 | |
| ECTS credits and teaching methods | ECTS credits | 7 |
| | Workload (L+(AE+LE+CE)+S) | 45+(15+15+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Present skills in the area of intelligent systems. Introduce required intelligent agent features for problem solving. Develop problem state space. Describe problem solving in first order logic. Introduce students with knowledge representation, planning and decision making procedures in environment with or without uncertainty. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.design, define and describe intelligent agent features for a specific problem solving task<br>2.develop a problem solving algorithm costumised for a specific agent<br>3.design, solve and evaluate the solution of a problem recorded in the first order logic<br>4.present information (knowledge) in a form suitable for processing by an agent<br>5.identify process uncertainties and develop process plan with known uncertainty<br>6.formulate a problem solving algorithm tailored for execution by an agent<br>7.create a space state diagram and an action plan for an agent | |
| *1.4. Course content* | |
| Intelligent agents. Problems and their search spaces. Types of search. Blind search. Heuristic search algorithms. Logical agents. First order predicate logic. Modal and temporal logic. Deductive and nondeductive reasoning methods. Designing contradictory and undefined systems. Possible worlds. Damster Shafer theory. Ad-hoc and heuristic learning methods. Structured knowledge. Knowledge presentation. | |
| *1.5. Teaching methods* | Lecture<br>Auditory exercises<br>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%. | 4 | 8 |
| Practice – problem solving | 1.5 | 2,3,7 | Midterm exam | Evaluation of (written) exercises | 16 | 32 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 1,3,4,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 10 | 20 |
| Oral exam | 2 | 1,2,4,6 | Oral exam | Assessment of student's answers | 16 | 32 |
| Homework. | 1 | 2,3,4,7 | Homework | Problem solving analysis. | 0 | 8 |

*1.10. Obligatory literature*

1 Russel, S.; Norvig, P. Artificial Intelligence: A Modern Approach Prentice Hall, 2000.

*1.11. Recommended additional literature*

1 Jović F. Expert Systems in Process Control Chapman and Hall, London, 1992.
2 Patterson D.W. Introduction to Artificial Intelligence and Expert Systems Prentice Hall Int. 1990.
3 Russel S. i Norvig P. Artificial Intelligence: A Modern Approach Prentice Hall 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 | Doc.dr.sc. BALEN JOSIP | |
| Course name | DA4R4I-10 Intelligent Transportation Systems | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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+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<br>2.explain the benefits of new technologies embedded in vehicles and transportation infrastructure<br>3.analyse, compare and evaluate various information dissemination approaches in VANETs<br>4.develop and implement algorithms for message dissemination in VANETs<br>5.conduct algorithm test by using traffic and network simulators<br>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<br>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 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. JOB JOSIP, Doc.dr.sc. GRBIĆ RATKO | |
| Course name | DRdKb3-03 Internet of Things | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory) | |
| Course status | Mandatory | |
| Year of study | 2 | |
| 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* | |
| Introduce basic theoretical knowledge and practical skills in the field of Internet of Things to students. Teach them how to use and work on projects of collecting, storing, processing and visualizing the data in accordance with the Internet of Thing paradigm. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the second year of the study programme | |
| *1.3. Learning outcomes* | |
| 1.evaluate and explain the elements' appropriateness of the given IoT system<br>2.evaluate the tool appropriateness for developing a programming code of a microcontroller system in a specific project<br>3.develop a custom software solution by using appropriate libraries for more than one sensor in a microcontroller system<br>4.to propose the design of the IoT system for the given simple problem<br>5.apply the theoretical basis for making a simple system in the Internet of Things | |
| *1.4. Course content* | |
| Introduction to the Internet of Things (IoT). IoT technologies (elements, circuits, communication, platforms and development environments). IoT architecture and infrastructure. Collecting and storing data (mechanisms, protocols, applications and services). Data access (real-time, on-demand, publish/subscribe). User interfaces and data visualisation. Application of Internet facilities: industry, meteorology, agriculture, medicine, smart homes, smart cities. | |
| *1.5. Teaching methods* | Lecture<br>Laboratory exercises<br>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 | | Teaching method | Assessment method | Points |
|---|---|---|---|---|---|

| | | Learning outcomes | | | Min | max |
|---|---|---|---|---|---|---|
| Attendance Lectures, Laboratory exercises, Design exercises | 1 | 1 | Lectures, Laboratory exercises, Design exercises | Attendance register. Mandatory attendance percentage is: 25%. | 5 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 2 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 5 | 10 |
| Oral exam | 2 | 4 | Oral exam | Assessment of student's answers | 20 | 40 |
| Problem-solving related to design exercises | 1 | 3 | Design exercises | Evaluation of problem solving exercises | 5 | 10 |
| Seminar paper | 2 | 5 | Presenting a seminar paper | Presentation of a seminar paper | 15 | 30 |

*1.10. Obligatory literature*

1 Bahga, A., Madisetti V. Internet of Things: A Hands-on-Approach Arshdeep Bahga & Vijay Madisetti, 2014.

*1.11. Recommended additional literature*

1 Dieter Uckelmann, Mark Harrison, Florian Michahelles Architecting the Internet of Things Springer, 2011.
2 Charalampos Doukas Building Internet of Things with the Arduino: 1 CreateSpace Independent Publishing Platform, 2012.
3 H. Zhou The Internet of Things in the Cloud: A Middleware Perspective Boca Raton, CRC Press, 2012.
4 A. McEwen, Hakim Cassimally Designing the Internet of Things John Wiley & Sons, 2013.

*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. NYARKO EMMANUEL-KARLO | |
| Course name | DRb2-03-18 Soft Computing | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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* | |
| This course provides the necessary mathematical background for understanding and implementing neural networks, genetic algorithms and fuzzy systems. The course introduces case studies to students where neural networks, genetic algorithms, and fuzzy logic are implemented in solving problems in the area of optimisation, pattern recognition, automatic control, and expert systems. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.compare soft and classical computing<br>2.describe the basic working principle of a genetic algorithm<br>3.list several properties of neural networks and their applications<br>4.compare fuzzy logic with classical logic and list examples where fuzzy logic can be applied<br>5.adapt a genetic algorithm to solve optimisation problem<br>6.design neural networks to solve pattern recognition problems | |
| *1.4. Course content* | |
| Comparison of conventional and soft computing methods. Neural networks. Basic concepts, types of networks, learning methods. Applications in signal processing and pattern recognition. Genetic algorithms. Basics of evolution. Concept of individuals and population, definition of genes. Recombination and mutation operators. Fitness functions. Applications in optimisation and pattern classification. Fuzzy logic. Comparison with classical logic, fuzzy sets. Membership functions, fuzzy operators, rules, defuzzification. Application in automatic control and building expert systems. Example of integration of the described methods: adjusting a fuzzy controller using neural networks and genetic algorithms. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3,4 | Lectures, Laboratory exercises | | 7 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1.5 | 5,6 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 15 | 30 |
| Oral exam | 1 | 1,2,3,4,5,6 | Oral exam | Assessment of student's answers | 18 | 35 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 0.5 | 5,6 | Solving project tasks | Evaluation of a project assignment, presentation grading | 0 | 25 |

*1.10. Obligatory literature*

1 Tettamanzi, A. G. B; Tomassini, M. Soft Computing: Integrating Evolutionary, Neural, and Fuzzy Systems Springer-Verlag Berlin Heidelberg, 2001.

*1.11. Recommended additional literature*

1 B. Krose, P. van der Smagt An introduction to neural networks University of Amsterdam, 1996.
2 J.-S. R. Jang, C.-T. Sun, E.Mizutani Neuro-Fuzzy and Soft Computing Prentice Hall, 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 | Prof. dr. sc. CRNJAC-MILIĆ DOMINIKA | |
| Course name | D4-01 Management | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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* | |
| Students will get acquainted with all elements of enterprise management. In this way, they will be ready to work in the economy, develop conceptual skills more easily when pursuing self-employment, or stand out as quality employees in company management or an organisational unit. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the second year of the study programme | |
| *1.3. Learning outcomes* | |
| 1.define and explain basic management functions<br>2.determine basic management skills and their importance for managers<br>3.suggest organisational management approaches to a company based on acquired knowledge<br>4.assess the appropriateness of an organisational structure for the enterprise<br>5.analyze skills that help managers to become successful<br>6.compare leadership and management | |
| *1.4. Course content* | |
| Introduction and development of the management theory, contemporary trends in the management theory and practice, management ethics, corporate social responsibility management, business planning, prediction, decision making, nature of an organisation, formation of an organisational structure and organisation promotion, strategy concept, strategic management and strategy levels, development of a strategic plan, strategic project management, selection and recruitment of personnel, training and development of personnel, communication and communication skills important for successful management, work motivation, compensation management (compensation for work performed, compensation from profit share, managerial compensation), control, information technology and management, business intelligence, management skills, category management. | |
| *1.5. Teaching methods* | Lecture<br>Auditory 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, Auditory exercises | 1.3 | 1,2,3,4,5,6 | Lectures, Auditory exercises | Attendance register. Mandatory attendance percentage is: 25%. | 0 | 10 |
| Practice – problem solving | 0.7 | 4,5 | Midterm exam | Evaluation of (written) exercises | 5 | 10 |
| Oral exam | 1 | 1,2,3,4,5,6 | Oral exam | Assessment of student's answers | 25 | 50 |
| Seminar paper | 0.5 | 1,2,5 | Studying literature related to the subject of seminar work and writing seminar work. teamwork. | According to the guidelines for writing a seminar work, grading the content and style of a seminar paper | 0 | 15 |
| Creating a ppt presentation and exposing the topic of seminar work. | 0.5 | 1,2,5 | According to instructions given by the teacher, students prepare a presentation on a given seminar paper topic, while simultaneously following the content of the previously written paper. | After presenting a seminar paper, the teacher grades the activity by assigning points | 0 | 15 |

*1.10. Obligatory literature*

1 Buble, Marin Management Ekonomski fakultet Split, Split, 2008.
2 Z. Lacković Management elektrotehničkih djelatnosti Elektrotehnički fakultet Osijek, Osijek,2008.
3 P. Sikavica, F. Bahtijarević-Šiber, N. Pološki Vokić Temelji menadžmenta Sveučilište u Zagrebu, Školska knjiga, Zagreb,2008

*1.11. Recommended additional literature*

1 Caroselli M. Vještine vodstva za menadžere Mate d.o.o., Zagreb, 2014.
2 Cohen S. P. Vještine pregovaranja za menadžere Mate d.o.o., Zagreb 2014.
3 P. Kotler, K. L. Keller, M. Martinović Upravljanje marketingom, 14. Izdanje Mate d.o.o., Zagreb 2014.
4 Buble M., Klepić Z. Menadžment malih poduzeća: Osnove poduzetništva Ekonomski fakultet Sveučilišta, Mostar, 2007.
5 Certo S., Certo T. Moderni menadžment Mate d.o.o., Zagreb, 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, Prof.dr.sc. MARTINOVIĆ GORAN | |
| Course name | DRac1-06-18 Methods and Techniques of Software Testing | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (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* |
| Explain the models, methods and software testing techniques, manual and automated testing, planning and testing procedure. Present and analyse possibilities, selection and ways of using testing techniques through a software life-cycle, according to different models, as well as static and dynamic, functional and non-functional testing by using appropriate testing standards. Train students for testing cases and scenario design in agile, embedded, web and mobile programming environments by using appropriate tools for testing automation and software code improvement. |
| *1.2. Conditions for enrollment* |
| Requirements for the enrolment in the graduate university study programme |
| *1.3. Learning outcomes* |
| 1.understand reliability models, methods and techniques of manual and automated software testing through a software life-cycle and by using appropriate models and testing dynamics<br>2.define and create necessary development and testing environment for functional and non-functional testing as well as for test-driven development<br>3.apply defined development and testing environment, tools for manual and automated testing for testing cases and scenario design in embedded, agile, web and mobile environments and testing documentation<br>4.evaluate testing results with the aim of improving testing methods and techniques, risk estimation and decrease, as well as the improvement of a programming code by testing<br>5.test the level of meeting testing standards for provided software solutions<br>6.analyse and modify software with the aim of improving software and testing procedures |
| *1.4. Course content* |
| Introduction and basic terminology, software reliability, models of software testing, methods and techniques of testing software systems. Goals and limitations of testing. Manual and automated testing. Planning and monitoring of testing. Testing management. Testing through a software life-cycle. Selection of testing techniques. Testing according to black-, white- and grey-box. Static and dynamic testing. Functional and non-functional software testing methods - unit testing, integration testing, system testing, regression testing, acceptance testing, performance testing (load, stress), structural testing, model-based testing, testing of object-oriented software, usability, portability and user experience testing. Testing and error/failure documentation. Error/failure analysis. Test case and testing scenario design. Testing process. Test-driven development. Code refactoring. Testing standards (ISO/IEC 9126, 9241-11, 25000:2005, 12119, other). Testing risks. Testing in agile development. Testing of embedded software solutions. Web and mobile applications testing. Tools for automated testing. Testing examples in considered environments. |

| | |
|---|---|
| *1.5. Teaching methods* | Lecture<br>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 | 1,2 | Lectures, Laboratory exercises | | 0 | 5 |
| 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 | 10 | 20 |
| Oral exam | 1 | 1,4,5,6 | Oral exam | Assessment of student's answers | 10 | 20 |
| Solving problem, model and program tasks. | 1 | 2,3,4 | Midterm exam | Evaluation of (written) exercises | 12.5 | 25 |
| Project asignment | 1 | 3,4,5,6 | Practical work | Evaluation of problem solving exercises | 15 | 30 |

*1.10. Obligatory literature*

1 B. Laboon A Friendly Introduction to Software Testing CreateSpace Independent Publishing Platform, 1st Ed., 2016.
2 G.J. Myers, C. Sandler The Art of Software Testing Wiley; 3rd Ed., 2016.
3 G. Paskal Test Automation in the Real World: Practical Lessons for Automated Testing Independently published, 2017.
4 Pezzé; M; Young, M. Software Testing and Analysis: Process, Principles, and Techniques John Wiley & Sons, 2008

*1.11. Recommended additional literature*

1 S. McMaster Web Application Testing for Developers 2017.
2 K. Nuvvula How to Test Mobile Applications: A Practical Guide to Mobile Application Testing Kishore Nuvvula, 1st Ed., 2016.
3 J.W. Grenning Test Driven Development for Embedded C (Pragmatic Programmers) Pragmatic Bookshelf, 1st Ed., 2011.

*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 | CRNKOVIĆ IVICA | |
| Course name | DRc1-05 Software System Design and Modelling | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Software Engineering (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* | |
| Make students knowledgeable about the principles of modelling and design of software systems, and make them capable to use modelling languages for different types of software systems. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.design and model software systems using modeling languages<br>2.model software systems using UML<br>3.analyse safety of software systems<br>4.understand software systems management<br>5.have insights in different types of software systems, such as real-time systems, safety-critical systems and distributed systems | |
| *1.4. Course content* | |
| Software System Modelling gives students insights into the principles of modelling and designing large software systems. Most of todayâ€™s software systems are large and complex systems which require specification on a higher abstraction level than on a programming language level. The course will give an introduction to an overall, conceptual design, i.e. software architecture. It will provide theoretical bases for software system designing, architectural definition languages and UML, design patterns, model-based and component-based development. In addition, students will acquire practical knowledge through a set of laboratory exercises and projects. | |
| *1.5. Teaching methods* | Lecture<br>Auditory exercises<br>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 | 2 | 1,2,3,4,5 | Lectures, Auditory exercises, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 5 | 10 |
| Practice – problem solving | 1.5 | 1,2,3,4,5 | Midterm exam | Evaluation of (written) exercises | 25 | 50 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1.5 | 1,2,3,4,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 0 | 10 |
| Oral exam | 1 | 1,2,3,4,5 | Oral exam | Assessment of student's answers | 15 | 30 |

*1.10. Obligatory literature*

1 Sommerville, Ian Software Engineering, 9th Edition ISBN-13: 978-0137035151

*1.11. Recommended additional literature*

1 R. Gamma Design patterns: elements of reusable object-oriented software Addison Wesley, Boston, MA, 1998.

*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. SLIŠKOVIĆ DRAŽEN | |
| Course name | DRb3-03 Data based modeling | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (mandatory) | |
| Course status | Mandatory | |
| Year of study | 2 | |
| ECTS credits and teaching methods | ECTS credits | 7 |
| | Workload (L+(AE+LE+CE)+S) | 30+(0+30+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Introduce students to the basics of methodology for extracting knowledge about a process from the available measured data, and teach them how to build a process model with required properties based on these pieces of information. Present relevant skills required for handling available software tools for analysis and processing of measured data, as well as software tools for building process models based on these data. Acquaint students with the way of introducing intelligence into automatic control systems. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the second year of the study programme | |
| *1.3. Learning outcomes* | |
| 1.carry out the collection, analysis and preprocessing of measured data<br>2.highlight the advantages and disadvantages of a given process identification method<br>3.develop a dynamic mathematical model for a given problem by selecting an appropriate process identification method and implement it in Matlab<br>4.explain problems in process monitoring and in realization of the control system with the existence of difficult-to-measure process variables, and problem solving using estimators<br>5.evaluate the suitability of a particular modelling method based on the projection of the input data space into the latent space for a given problem<br>6.build a process model based on data by using analyzed methods and the Matlab program package | |
| *1.4. Course content* | |
| Modelling of processes and other functional relationships in data, based on measured data. Measured data obtained by a separate experiment and plant (operating) data. Measured data informativness. Sample time selection. Preprocessing of measured data and forming data sets for process model building. Building a static and dynamic model. Selection of input and output variables and model structure selection. Methods for model parameter estimation. Regression modelling. Non-recursive and recursive methods for model parameter estimation. Methods based on projection of input space into a latent subspace. Evaluation of the built process model. Application of artificial neural networks in data based modelling. Application of the Matlab software package based on data modelling. Virtual (soft) sensor and difficult-to-measure process variable estimation. Program implementation of built mathematical models into the industrial information system. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3,4,5,6 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 7 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 2 | 2,3,5,6 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 15 | 30 |
| Oral exam | 2 | 1,2,5,6 | Oral exam | Assessment of student's answers | 18 | 35 |
| Solving a project task | 1 | 1,2,3,4,5,6 | Project | Evaluation of project task solutions | 0 | 25 |

*1.10. Obligatory literature*

1 Perić, N., I. Petrović Identifikacija procesa FER, Zagreb, 2000.,
2 Fortuna, L., S. Graziani, A. Rizzo, M.G. Xibilia Soft sensors for Monitoring and Control of Industrial Processes Springer-Verlag London Limited 2007.

*1.11. Recommended additional literature*

1 Ljung, L. System Identification - Theory for the User Prentice-Hall, Eaglewood Cliffs, 1987.,
2 Haykin, S. Neural Networks – A Comprehensive Foundation, 2nd edition Prentice Hall, 1999.,
3 Martens, H., T. Naes, Multivariate Calibration, 2nd edition John Wiley & Sons, New York, 1991.

*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. LUKIĆ IVICA | |
| Course name | DKR4I-03 Advanced Web Programming | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| The aim of the course is to clarify the user interface design process as well as the background application when developing internet applications. Students will get familiarised with complex programme frameworks which are used for developing internet applications, which is a process fundamentally different from the usual application development processes without the use of frameworks. Students will be introduced to newer software frameworks for fast development of high quality and interactive internet applications. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the second year of the study programme | |
| *1.3. Learning outcomes* | |
| 1.compare different client side technologies for creating internet applications<br>2.evaluate different server side technologies for creating internet applications<br>3.create complex software solutions based on advanced web technologies and services<br>4.analyse and solve a specific problem, combine different technologies and software frameworks to create a web application | |
| *1.4. Course content* | |
| Access to creating web documents using different technologies and programming frameworks. Introduction to the MVC concept. Client side technologies: HTML (syntax, standard structure, hypertext, forms), Cascading Styles, JavaScript, JavaScript and HTML, dynamic JavaScript documents, jQuery, AngularJS, Bootstrap. Server side technologies: PHP, ASP, and ASP.NET. Access database (PHP/SQL), CakePHP, Zend, Laravel. Creating advanced internet applications and application examples. Part of the course is carried out by independent research work with the basic sources and latest technologies. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 6 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 2,3,4 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 15 | 20 |
| Oral exam | 1 | 1,2,3 | Oral exam | Assessment of student's answers | 20 | 40 |
| Project | 1 | 2,3,4 | Development of web application | Verification of solved tasks | 15 | 30 |

*1.10. Obligatory literature*

1 MacIntrye, Peter; Tatroe Kevin; Lerdorf Rasmus Programiranje PHP treće izdanje O Reilly i IT Expert, 2015.
2 Shackelford, Adam Beginning Amazon Web Services with Node.js New York: Apress, 2015.
3 R. Delorme Programming in HTML5 with Javascript and CSS3 Microsoft Press, Redmond Washington, 2014.

*1.11. Recommended additional literature*

1 L. Revill jQuery 2.0 Development Cookbook Packt Publishing Ltd. Livery Place 35 Livery Street Birmingham B3 2PB, UK, 2014.
2 K. Williamson Learning AngularJS Published by O Reilly Media, Inc., 1005 Gravenstein Highway North Sebastopol, CA 95472, 2015.
3 L. Ullman PHP Advanced and Object-Oriented Programming: Visual QuickPro Guide (3rd Edition) Peachpit Press, 1301 Sansome Street, San Francisco, CA 94111, 2012.
4 R. Nixon Learning PHP, MySQL & JavaScript With jQuery, CSS & HTML5 O Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472, 2014.
5 A. K. Pande jQuery 2 Recipes Apress, Apress Media LLC 233 Spring Street New York, NY 10013, 2014.
6 C. Pitt Pro PHP MVC, Apress, Apress Media LLC 233 Spring Street New York, NY 10013, 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 | FERČEC IVANKA | |
| Course name | D4F-01 German | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (facultative)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (facultative)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (facultative)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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 â€“ 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)<br>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<br>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)<br>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: PrÄ¤sens, W-Fragen, Ja/Nein Fragen, Perfekt mit sein und haben, Modalverben kÄ¶nnen, mÄ¶gen); 4. write simple and short texts thematically related to the topics discussed in the course. | |
| *1.5. Teaching methods* | Lecture<br>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 | Homework evaluation | 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 | | |
| Course name | DRd1-05 Image Processing and Computer Vision | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory) | |
| Course status | Mandatory | |
| Year of study | 1 | |
| ECTS credits and teaching methods | ECTS credits | 6 |
| | Workload (L+(AE+LE+CE)+S) | 45+(0+30+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Introduce students to basic methods used in image processing and computer vision, from basic image transformation, image enhancement, feature extraction to basic computer vision algorithms. Through programme tasks, students are introduced to the ways in which image processing algorithms and computer vision work. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.define and describe the concepts of image processing and computer vision<br>2.describe the methods of image processing and computer vision<br>3.apply the basics of image processing and computer vision and evaluate results<br>4.analyse a practical problem of digital image processing<br>5.use and customise the basic image processing and computer vision algorithms and interpret results<br>6.interconnect acquired knowledge and apply methods for processing image and computer vision in open source applications and interpret results | |
| *1.4. Course content* | |
| Definitions, image types, discretisation, degradations in digital images. Image transformations: continuous Fourier transform, discrete Fourier transform, image pyramids, discrete wavelet transform. Colour perception and colour spaces. Image compression. Image interpolation. Image enhancement: point operations, linear filters, wavelet shrinkage, median filters, m-smoothers, morphological filters, nonlinear diffusion filtering, Discrete Variational Methods, Continuous Variational Methods, Fourier methods and deconvolution. Feature extraction: edges, edges in multichannel images and corners, contour representations and Hough transform. Texture analysis. Segmentation: classical methods, optimisation methods. Image sequence analysis: local methods, variational methods. 3-D reconstruction: camera geometry, stereo, shape-from-shading. Object recognition: invariants, eigenspace methods. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 0 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 3,4,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 10 | 20 |
| Oral exam | 2 | 1,2,3,6 | Oral exam | Assessment of student's answers | 25 | 50 |
| Revision exams | 1 | 3,4,5,6 | Midterm exams (written exam) | Homework evaluation | 10 | 20 |

*1.10. Obligatory literature*

1 Gonzalez, R.C.G.; Woods, R. E. Digital Image Processing New Jersey: Pearson Education, 2008.

*1.11. Recommended additional literature*

1 E. Trucco, A. Verri Introductory Techniques for 3-D Computer Vision Prentice Hall, New Jersey, 1998.
2 J. Bigun Vision with Direction Springer, Berlin, 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 | Izv. prof. dr. sc. BLAŽEVIĆ DAMIR | |
| Course name | DRac3-03 Quality Assurance of Software Support | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory) | |
| Course status | Mandatory | |
| Year of study | 2 | |
| ECTS credits and teaching methods | ECTS credits | 7 |
| | Workload (L+(AE+LE+CE)+S) | 30+(15+15+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Enable insight to software quality, software quality metrics, software quality assurance and life cycle models. Present procedures, techniques and standards for software life cycle management, software development, implementation, testing and retirement. | |
| *1.2. Conditions for enrollment* | |
| The necessary requirements to enrol in the second year of the studies. | |
| *1.3. Learning outcomes* | |
| 1.distinguish and recognise software quality factors<br>2.recognise, differentiate and apply the existing software development standards<br>3.evaluate the complexity of a software project and determine the required resources<br>4.organise, lead, participate in a software development team for automotive applications<br>5.plan, design, develop and test software for automotive applications<br>6.recognise, understand and evaluate the engineering processes and practices used in the automotive software industry and apply it to improve the software development process | |
| *1.4. Course content* | |
| Software quality programme organisation. Process quality management. The software crisis. Standardisation of quality assurance. The cost of software quality. Static and dynamic analysis applied to quality assurance. Software reliability. Software reliability management. Software testing. Software maintenance and configuration management. | |
| *1.5. Teaching methods* | Lecture<br>Auditory exercises<br>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 | 2 | 1,2,3,6 | Lectures, Auditory exercises, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 50%. | 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 | 2 | 1,2,3,4,5,6 | Oral exam | Assessment of student's answers | 25 | 50 |
| Problem-solving related to design exercises | 1.5 | 2,3,4,6 | 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 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 | Prof.dr.sc. CUPEC ROBERT | |
| Course name | DRb2-05 Basics of Robotics | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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* | |
| Teach basic concepts of robotics - direct and inverse kinematics, dynamic robot manipulator model, path and trajectory planning, sensors and actuators in robotics, basics of mobile robot navigation. Provide an insight into the fields of robot applications. Teach students to understand and apply methods from the robotics field for robot manipulator and mobile robot control. | |
| *1.2. Conditions for enrollment* | |
| Requirements for the enrolment in the graduate university study programme | |
| *1.3. Learning outcomes* | |
| 1.formulate kinetic models of robot manipulators based on their mechanical specifications using Denavit-Hartenberg method<br>2.write a computer programme function for robot tool positioning by solving the inverse kinematics problem for a 6-axis robot manipulator with rotational joints where the last three axes intersect in a single point<br>3.explain basic robot manipulator control methods<br>4.list the basic types of motors and sensors used in robotics and explain the basic applications of sensors in robotics<br>5.develop a basic computer programme for robot manipulator control<br>6.develop a basic computer programme for mobile robot control | |
| *1.4. Course content* | |
| Introduction to robotics - basic terms, classification of robots and their applications. Direct and inverse kinematics of a robot manipulator. Denavit-Hartenberg convention. Robot manipulator trajectory planning. Dynamic model of a robot manipulator. Position and force control of a robot manipulator. Sensors and actuators in robotics. Basics of mobile robotics. Robot motion planning. Basics of mobile robot localisation. Description of robot pose uncertainty. Mobile robot localisation using Extended Kalman Filter (EKF) and Particle filter. Simultaneous Localisation and Mapping (SLAM). | |
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3,4 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 3 | 10 |
| Practice – problem solving | 0.4 | 1,2,3 | Midterm exam | Evaluation of (written) exercises | 10 | 20 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 0.8 | 1,2,5,6 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 8 | 20 |
| Oral exam | 1.2 | 1,2,3,4 | Oral exam | Assessment of student's answers | 20 | 40 |
| Problem-solving related to design exercises | 1 | 1,2,5,6 | Design exercises (KV) | Evaluation of problem solving exercises | 12 | 30 |

*1.10. Obligatory literature*

1 Kovačić Z.; Bogdan, S; Krajči, V. Osnove robotike Zagreb: Graphis, 2002.

*1.11. Recommended additional literature*

1 J. J. Craig Introduction to Robotics: Mechanics and Control Pearson Prentice Hall, Upper Saddle River, New Jersey, 2005
2 R. Siegwart, I. Nourbakhsh and D. Scaramuzza Autonomous Mobile Robots The MIT Press, Cambridge Massachusetts, 2011
3 J. C. Latombe Robot Motion Planning Norwell, Massachusetts, USA: Kluwer Academic Publishers, 1991
4 S. Thrun, W. Burgard, D. Fox Probabilistic Robotics Cambridge Massachusetts, 2006
5 R. Cupec Osnove inteligentnih robotskih sustava, udžbenik u izradi Zavod za računalno inženjerstvo i automatiku, ETF Osijek, 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).

| General information | | |
|---|---|---|
| Lecturer | Prof.dr.sc. HOCENSKI ŽELJKO | |
| Course name | DR3-01 Computer System Reliability and Diagnostics | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (mandatory) | |
| Course status | Mandatory | |
| Year of study | 2 | |
| ECTS credits and teaching methods | ECTS credits | 7 |
| | Workload (L+(AE+LE+CE)+S) | 45+(15+15+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Introduce students to theoretical and practical knowledge in the field of reliability and diagnostics of electronic components, digital circuits, computers and systems. | |
| *1.2. Conditions for enrollment* | |
| The necessary requirements to enrol in the second year of the studies. | |
| *1.3. Learning outcomes* | |
| 1.explain concepts in the area of reliability of computer systems<br>2.analyse and explain reliability models and confidence-building methods<br>3.explain and evaluate system reliability parameters<br>4.interpret and explain the obtained reliability and hardware support parameters<br>5.develop and apply relay reliability models in Relex program support<br>6.develop and apply reliability models of software support | |
| *1.4. Course content* | |
| Introduction and historical development in the field. Faults, malfunctions and errors of computer systems: causes and types of malfunctions. Models of malfunctions according to application and distribution of failures. Basic parameters and features of reliability, availability and system maintenance features. Reliability of components, assemblies and systems. Increasing reliability. Reduction and methods to avoid malfunctions. Fault detection procedures, self-diagnostic systems. Reliability of software support and models. Methods of specification and evaluation of computer systems, verification and validation. | |
| *1.5. Teaching methods* | Lecture<br>Auditory exercises<br>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 | 2.5 | 1,2,3 | Lectures, Auditory exercises, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 60%. | 2 | 5 |
| Practice – problem solving | 1.5 | 2,3,4 | Midterm exam | Evaluation of (written) exercises | 18 | 35 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 3,4,5,6 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 11 | 25 |
| Oral exam | 2 | 1,2,3,4 | Oral exam | Assessment of student's answers | 18 | 35 |

*1.10. Obligatory literature*

1 Kapur K.C; Pecht, M. Reliability Engineering John Wiley, 2014.
2 Pezzé; M; Young, M. Software Testing and Analysis: Process, Principles, and Techniques John Wiley & Sons, 2008

*1.11. Recommended additional literature*

1 B. W. Johnson Design and Analysis of Fault-Tolerant Digital System Addison-Wesley, Reading, 1989.
2 A. C. Brombacher Reliability by Design, CAE Techniques for Electronic Components and Systems John Wiley&Sons, 1992.
3 H. Pham, ed. Handbook of Reliability Engineering Springer, 2003.
4 D. Siewiorek, E. Swarz The Theory and Practice of Reliable System Design Digital Press, 1982.
5 M. A. Breuer, A. D. Friedman Diagnosis & Reliable Design of Digital Systems Computer Science Press, 1989.
6 P. P. O Connor, A. Kleyner Practical Reliability Engineering Wiley, 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 | Izv. prof. dr. sc. . FILKO DAMIR | |
| Course name | DRb4I-01-19 Programming Robots | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Introduce the capabilities of Robot Operating System (ROS). Show how ROS nodes are created and how can they communicate using ROS middleware. Show how mobile robots and robot manipulators are designed, simulated and controlled. Show the possibilities of navigation and map building of autonomous mobile robots by using ROS navigation stack. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the second year of the study programme | |
| *1.3. Learning outcomes* | |
| 1. Use Linux operating system.<br>2. Programming using Python programming language.<br>3. Explain the structure of Robot Operating System and its role in controlling robots.<br>4. Implement ROS nodes and enable their communication.<br>5. Model and simulate mobile robots and robot manipulators.<br>6. Apply ROS navigation stack for implementation of autonomous mobile robot. | |
| *1.4. Course content* | |
| Basic concepts and structure of Robot Operating System. Fundamentals of Linux operating system. Python programming language. ROS node. ROS topics, services and actions. Using rosbag for storing measurements and data. Designing mobile robot platforms. Designing robot manipulators. Simulators (Gazebo, Stage). Visualizing data in ROS (rviz). Controlling robot manipulators using “MoveIt!” motion planning framework. Navigating and map building using ROS navigation stack. Example of realistic mobile robot (Turtlebot 2). | |
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3,4,5,6 | Lectures, Laboratory exercises | | 7 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 1,2,3,4,5,6 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 10 | 30 |
| Oral exam | 1 | 1,2,3,4,5,6 | Oral exam | Assessment of student's answers | 18 | 30 |
| Solving project tasks | 1 | 1,2,3,4,5,6 | Solving project tasks | Evaluation of a project assignment, presentation grading | 0 | 30 |

*1.10. Obligatory literature*

1 Quigley, M., Gerkey B., Smart, W.D. Programming Robots with ROS OReilly Media, 2015.

*1.11. Recommended additional literature*

1 C. Schroder Linux Cookbook O Reilly, New York, 2004.
2 Lutz, M. Learning Python, 5th Edition O Reilly Media, 2013.
3 Fairchild, C., Harman, T.L. ROS Robotics by Example, 2nd edition Packt Publishing, 2017.
4 ROS Wiki (http://wiki.ros.org/)

*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. NENADIĆ KREŠIMIR, Dr.sc. MIOKOVIĆ ŽELJKA | |
| Course name | DI401-17 Service Learning Projects | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (elective) | |
| Course status | Elective | |
| Year of study | 2 | |
| ECTS credits and teaching methods | ECTS credits | 5 |
| | Workload (L+(AE+LE+CE)+S) | 15+(0+15+30)+0 |

| 1. Course description |
|---|
| *1.1. Goals* |
| Using the Service Learning (SL) as an educational method, the possibilities of applying, transferring and enhancing acquired academic knowledge and skills from the STEM area, primarily from the field of electrical engineering, computer science and information technology, will be presented to students in order to solve real problems in the community. This will help students understand the relevance of their knowledge and give them the feeling of doing something good, positive and beneficial to the community. Students will be encouraged to work in teams and collaborate in designing, implementing and evaluating an SL project through which they will be able to offer some technical, IT solutions and additional education in the field of basic and applied engineering knowledge and skills to specific community target groups. |
| *1.2. Conditions for enrollment* |
| Requirements met for enrolling in the study programme |
| *1.3. Learning outcomes* |
| 1.make a difference among service learning, volunteering, student practices and socially based research<br>2.critically evaluate the project as a structure of goals and activities and participate in team work on the project with the aim of developing technical and IT solutions that are subject to the programme of study<br>3.critically evaluate the methods and techniques of planning project activities and use the appropriate software tools behind design documentation (e-portfolio project)<br>4.manage the realisation of the project<br>5.create and present (in writing and orally) a project plan, final project report and documentation (e-portfolio) |
| *1.4. Course content* |
| The basic concepts of the Service Learning (SL) method, applicable technology for SL, examples of good practice from Croatia and abroad, methodology and design of the SL projects. Students will devise, prepare and work on projects during their laboratory exercises. Students will carry out projects through practical exercises. It is expected that other teachers will be involved to design and mentor projects for SL in the course plan. Designing, preparing, implementing and evaluating SL projects related to the transfer of STEM competencies in the field of electrical engineering, energy, renewable energy, robotics, automation.... |

| | |
|---|---|
| *1.5. Teaching methods* | Lecture<br>Laboratory exercises<br>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 | | | Lectures, Laboratory exercises, Design exercises | | | |
| 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 | 15 | 30 |
| Oral exam | 1 | 1,2,3,4,5 | Oral exam | Assessment of student's answers | 15 | 30 |
| Problem-solving related to design exercises | 1 | 1,2,3,4,5 | Design exercises | Evaluation of problem solving exercises | 15 | 30 |
| Attendance Lectures (PR), Laboratory exercises (LV), Design exercises (KV) | 1.5 | 1,2,3,4,5 | Lectures (PR), Laboratory exercises (LV), Design exercises (KV) | Lectures (PR), Laboratory exercises (LV), Design exercises (KV) | 5 | 5 |
| Keeping a work diary about project implementation in the community | 0.5 | 4,5 | Practical exercises | Evaluating a student project work diary | 5 | 5 |

*1.10. Obligatory literature*

1 N. Mikelić Preradović Učenjem do društva znanja: teorija i praksa društveno korisnog učenja Zagreb: Zavod za informacijske studije (2009.)

*1.11. Recommended additional literature*

1 E. Tsang Projects that Matter: Concepts and Models for Service-learning in Engineering Staylus Publishing, 2000.
2 A. R. Bielefeldt Service Learning in Engineering Michigan Technological University, 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 | Izv. prof. dr. sc. BLAŽEVIĆ DAMIR, Izv. prof. dr. sc. GRGIĆ KREŠIMIR | |
| Course name | DRa2K4I-05 Computer System Networks - Planning and Design | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (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* | |
| Provide students with practical knowledge in computer network design. Through lectures and exercises, train them for user requirement analysis, design, planning, configuration, implementation, analysis and debugging of a computer network. Introduce students to legal and technical regulations related to planning and construction. Special emphasis will be placed on project documentation, cost list, configuration files for network devices (computers for special purposes), their implementation and maintenance. Introduce students to practical approach in quality of service implementation in a specific network environment. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the second year of the study programme | |
| *1.3. Learning outcomes* | |
| 1.recognise and describe problems in modern computer network management<br>2.demonstrate the development of LAN communication cables, make and verify the validity of a simple and extended LAN network by layers, use a network traffic analyser and elaborate on results<br>3.calculate and choose a scheme of IP addresses and masks for an arbitrary network<br>4.plan and design a local computer network, choose and explain the choice of passive and active network equipment<br>5.create a configuration file for a network device (switch and router) according to given conditions, implement it on a networking device and analyse the device operation<br>6.classify and categorise network traffic types, create and test lists for network traffic filtering, propose QoS settings | |
| *1.4. Course content* | |
| Introduction to legal and technical regulations related to computer network planning. Designing project documentation. Computer networks. Types and classification of computer networks. Passive and active network devices. Computer hardware and software. Composing configuration files for network nodes. Computer network planning, equipment specification, building and maintenance. Implementation of quality of service settings. Access lists creation. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1,4,6 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 4 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 2,3,4,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 8 | 15 |
| Oral exam | 1 | 1,4,6 | Oral exam | Assessment of student's answers | 18 | 35 |
| Revision exams | 1 | 2,3 | Midterm exams (written exam) | Evaluation of exercises | 8 | 20 |
| Seminar paper | 1 | 1 | Pair work | Delivering and presentation of seminar papers | 0 | 20 |

*1.10. Obligatory literature*

1 M. Radovan Računalne mreže 1 Digital Point Tiskara, Rijeka 2010.
2 M. Radovan Računalne mreže 2 Digital Point Tiskara, Rijeka 2011.

*1.11. Recommended additional literature*

1 L.L.Peterson, B.S. Davie Computer Networks: A Systems Approach Morgan Kaufmann, Burlington (Massachusetts), 2012.
2 H.Fred Data Communications, Computer Networks and Open Systems Addison-Wesley, London, 1996.

*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. MARTINOVIĆ GORAN | |
| Course name | DRacd3-02 Distributed Computer Systems | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory) | |
| Course status | Mandatory | |
| Year of study | 2 | |
| ECTS credits and teaching methods | ECTS credits | 7 |
| | Workload (L+(AE+LE+CE)+S) | 45+(0+15+0)+0 |

| 1. Course description |
|---|
| *1.1. Goals* |
| Provide students with insight and basic knowledge of the properties, prerequisites and ways of establishing, using and evaluating distributed computer systems, parallel systems and service-oriented systems. Show opportunities and explain the basics of using system and software tools, and develop applications in distributed and service-oriented computing environments. |
| *1.2. Conditions for enrollment* |
| The necessary requirements to enrol in the second year of the studies. |
| *1.3. Learning outcomes* |
| 1.understand principles, system and program mechanisms, development environments, paradigms and languages of parallel, distributed and service-based computer systems<br>2.analyze and compare the applicability of principles, mechanisms, algorithms and environments on which distributed and service-based computer systems operation is based<br>3.create more advanced software solutions that enable effective parallel, distributed and service-level problem-solving in current programming environments and languages by applying the adopted principles, mechanisms, algorithms and development tools<br>4.use of current parallel, distributed and service-based computing environments and development tools on the advanced user, system and program level<br>5.analyze, evaluate, and plan the use of parallel, distributed, and service-based computer systems as for solving problems in business, scientific and industrial applications |
| *1.4. Course content* |
| Definition, goals and models of distributed computer systems. Communication: layered protocols, remote procedure calls and object invocation, sockets. Processes: threads, client-server processes, P2P environment, code migration, agents. Naming of distributed system entities. Synchronization: logical clock, global state, algorithms of election and mutual exclusion, transactions. Consistency and replication. Fault tolerance on the process, client-server and group communication level. Security: secure channels, authentication control. Distributed systems based on objects, documents, coordination and services. Distributed environments: clusters and computational grid. Parallel programming: MPI, OpenMP. Relation computational grid, web services, mobile and Internet technologies. Service-oriented architectures (SOA). Collective intelligence and Web 2.0. SOAP, WSDL, RESTFul API. Cloud Computing: resource management, workload balancing, |

scalability, message exchange, models, standards, algorithms, languages and systems software. Distributed embedded systems. Green computing. Performance evaluation. Application examples: business intelligence, medicine and pharmacy, research, industry.

| | |
|---|---|
| *1.5. Teaching methods* | Lecture<br>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 | 1.5 | 1,2,3,4,5 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 50%. | 3 | 6 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1.5 | 3,4,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 12 | 24 |
| Oral exam | 1 | 1,2,5 | Oral exam | Assessment of student's answers | 15 | 30 |
| Solving problem, model and program tasks. | 2 | 1,2,5 | Written exam | Checking solutions during a written exam and laboratory exercise reports | 15 | 30 |
| Solving practical program tasks. | 1 | 3,4,5 | Course report. | Checking the correctness of the solution via laboratory excercises and lectures | 5 | 10 |

*1.10. Obligatory literature*

1 Varela, C.A;, Agha, G. Programming Distributed Computing Systems: A Foundational Approach MIT Press, 2013.
2 A.S. Tanenbaum, M. van Steen Distributed Systems: Principles and Paradigms (2nd Ed.) Prentice Hall, 2013.
3 M. van Steen, A.S. Tanenbaum Distributed Systems (3.01 Ed.) CreateSpace Independent Publishing Platform, 2017.

*1.11. Recommended additional literature*

1 J. Blazewicz, K. Ecker, B. Plateau, D. Trystram (Eds.) Handbook on Parallel and Distributed Processing Springer - Verlag, 2000.
2 A.D. Kshemkalyani, M. Singhal Distributed Computing: Principles, Algorithms and Systems Cambridge University Press, 2011.
3 M.J. Kavis Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS) Wiley, 2014
4 M. Parashar, S. Hariri Autonomic Computing: Concepts, Infrastructure, and Applications CRC Press, 2006.
5 M.T. Higuera-Toledano, A.J. Wellings Distributed, Embedded and Real-time Java Systems Springer, 2012.

6 S. Ghosh Distributed Systems: An Algorithmic Approach Chapman & Hall, 2014.
7 P. Pacheco An Introduction to Parallel Programming Morgan Kaufmann, 2011.
8 J. Rhoton Cloud Computing Explained: Implementation Handbook for Enterprises Recursive Press, 2009.

*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. GRBIĆ RATKO, Prof.dr.sc. SLIŠKOVIĆ DRAŽEN | |
| Course name | DRbd1-06-18 Pattern Recognition and Machine Learning | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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 students to the principles and methods in the field of pattern recognition and machine learning. Present software tools for empirical data analysis and machine learning that enable pattern recognition problem solving and data mining in different areas of engineering as well as human activities in general. Introduce theoretical backgrounds for several courses that follow and are related to the application of pattern recognition theory. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.define the basic concepts of pattern recognition theory and machine learning<br>2.suggest a way to solve a specific problem with a machine learning approach<br>3.develop your own software solution using appropriate libraries that contain implemented methods and machine learning algorithms<br>4.assess the suitability of a particular unsupervised learning algorithm for a given problem<br>5.assess the suitability of a particular supervised learning algorithm for a given problem<br>6.explain ways of model selection and evaluation | |
| *1.4. Course content* | |
| Introduction to machine learning. Unsupervised and supervised learning. Parametric and nonparametric methods. Regression and classification methods. Neural networks. Support vector machines. Kernel methods. Data clustering. Dimensionality reduction and feature extraction. Model selection. Results validation. Basics of the decision theory. Different applications of machine learning and examples. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1.5 | 1,2,3,4,5,6 | Lectures, Laboratory exercises | | 7 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1.5 | 2,3,4,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 15 | 30 |
| Oral exam | 1.5 | 1,2,4,6 | Oral exam | Assessment of student's answers | 18 | 35 |
| Solving a project task | 0.5 | 1,2,4,6 | Project | Evaluation of project task solutions | 0 | 25 |

*1.10. Obligatory literature*

1 Alpaydin, E. Introduction to Machine Learning MIT Press, 2014.
2 T. Hastie, R. Tibshirani, J. Friedman The Elements of Statistical Learning: Data Mining, Inference, and Prediction Springer, 2009.

*1.11. Recommended additional literature*

1 Haykin, S. Neural Networks – A Comprehensive Foundation, 2nd edition Prentice Hall, 1999.
2 C.M. Bishop Pattern Recognition and Machine Learning Springer, 2007.

*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 | DRcKb2-05 Mobile platform application development | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Software Engineering (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+15)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Introduce students to technologies for developing mobile applications. Show how a user interface is developed, and explain application functionality and interface connectivity and functionality. Teach students how to test apps on devices and a simulator, and how to develop source code documentation. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.identify application-specific concepts for mobile applications<br>2.use a mobile application development platform<br>3.develop a complex mobile application and programme a user interface<br>4.implement structured and functional testing of applications on real-world mobile devices<br>5.create source code documentation of the application<br>6.recommend alternative approaches to solving a specific problem encountered during testing | |
| *1.4. Course content* | |
| Introduction to mobile application development tools. The main components of a mobile application. User interface design for mobile applications. Software solutions to real problems. The use of a program-specific concept to create mobile applications. Software design implementation. Software implementation of different functionalities. The use and management of sensors embedded in mobile devices. The use of a simulator to test application performance. Performing structural and functional testing on real-world mobile devices. Source code documentation generation | |
| *1.5. Teaching methods* | Lecture<br>Laboratory exercises<br>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 | 1,6 | 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 | 0.4 | 2,3,4 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 0 | 15 |
| Oral exam | 0.3 | 1,3,6 | Oral exam | Assessment of student's answers | 20 | 40 |
| Problem-solving related to design exercises | 1 | 2,3,4,5 | Design exercises | Evaluation of problem solving exercises | 0 | 10 |
| Designing a software solution | 1.3 | 2,3,4,5 | Independent work on a software solution | Testing and presentation of the created application | 10 | 30 |

*1.10. Obligatory literature*

1 Razvoj mobilnih aplikacija-priručnik za edukaciju Osijek: Elektrotehnički fakultet Osijek, 2013.
2 Phillips, Bill; Stewart, Chris; Hardy, Brian; Marsicano, Kristin Android Programming: The Big Nerd Ranch Guide (2nd Edition) Atlanta: Big Nerd Ranch, LLC., 2015,

*1.11. Recommended additional literature*

1 P. Sarang Java Programming Oracle Press, 2012.
2 I. F. Darwin Android Cookbook Problems and Solutions for Android Developers O Reilly Media, 2012.
3 R. Cadenhead Java 6 II izdanje Kombib, 2008.
4 D. Poo, D. Kiong, S. Ashok Object-Oriented Programming and Java Springer Verlag, 2007.
5 Reto Meier Professional Android 4 Application Development Wiley, 2012.
6 M. Gargenta Learning Android - Building Applications for the Android Market O Reilly Media, 2011.
7 Y. Fain Programiranje Java Wrox, 2011.

*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. LIVADA ČASLAV | |
| Course name | DRd2-05 Game Development | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (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* | |
| Expand the knowledge of object-oriented programming needed to create a computer game. Introduce students to the concept of Direct3D and explain it on an example of drawing 2D and 3D models, texturing on models and optimizing geometry. Explain DirectInput to students, i.e. a faster and more accurate way to control objects in computer games and get feedback on movement. Clarify the connection of sound fx and music with a computer game, and explain the creation of 3D sound with DirectSound. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.compare the elements for computer games development and determine which basic elements are needed to create computer games<br>2.plan which tools and programme libraries are needed to design a computer game<br>3.according to the established theoretical basis, construct a simple computer game<br>4.interpret and analyse the design of computer games | |
| *1.4. Course content* | |
| Introduction to the development of computer games. Object-oriented programming with the emphasis on C# - classes and objects, interfaces, data access, pre-processing of data. Selections. Direct3D API - DirectX interface for graphical manipulation of objects in 2D and 3D space. Colours. Textures. Signal sequences. DirectInput. Mouse control, keyboard, gamepad control. Force feedback. DirectSound. 3D sound. 2D and 3D models of games. Design of computer games. Interaction. Animation. Physics of computer games. Touch detection. Artificial intelligence. | |
| *1.5. Teaching methods* | Lecture<br>Laboratory exercises<br>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 | 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 | 2 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 5 | 10 |
| Oral exam | 0.5 | 4 | Oral exam | Assessment of student's answers | 25 | 50 |
| Problem-solving related to design exercises | 2.5 | 3 | Design exercises | Evaluation of problem solving exercises | 0 | 30 |

*1.10. Obligatory literature*

1 Hocking, Joe Unity in Action: Multiplatform Game Development in C# with Unity 5 Shelter Island NY: Manning Publications, 2015.

*1.11. Recommended additional literature*

1 D. Graham Game Coding Complete Cengage Learning PTR, 4th Edition, 2012.
2 S. Rogers Level Up!: The Guide to Great Video Game Design John Wiley & Sons, 2010.
3 R. Penton Beginning C# Game Programming Cengage Learning PTR; 1st edition, 2004.
4 D. Schuller C# Game Programming: For Serious Game Creation Cengage Learning PTR; 1st edition, 2010.
5 J. Gibson Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C# Addison-Wesley, 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 | Prof.dr.sc. CUPEC ROBERT | |
| Course name | DRb1-18 Computational Geometry and Robot Vision | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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* | |
| Explain the representation of basic geometric structures and spatial relations by appropriate data structures. Explain the basic methods for an efficient analysis of image and 3D sensor data. Explain the use of programing tools for image and 3D sensor data processing. Explain how to implement programme solutions to image and 3D sensor data analysis problems with the application in robotics and intelligent autonomous systems. | |
| *1.2. Conditions for enrollment* | |
| Requirements for the enrolment in the graduate university study programme Computer Engineering. | |
| *1.3. Learning outcomes* | |
| 1.understand the basic principles of common methods and tools for image and 3D sensor data processing<br>2.select appropriate methods for solving problems in the field of image and 3D sensor data processing<br>3.select appropriate data structures for representation of 2D and 3D geometric structures and their relations<br>4.develop computer programmes for image processing using available software development tools<br>5.develop computer programmes for 3D sensor data processing using available software development tools<br>6.develop programme solutions for recognition of objects in 3D point clouds obtained by 3D sensors and estimation of object pose with respect to the camera | |
| *1.4. Course content* | |
| Basic concepts - coordinate system, point, line, line segment, vector, plane, face, polygon, polyhedron, normal. Description of the position and orientation of a rigid body. Transformation between coordinate systems. Plane and space partition. Triangulation. Delaunay triangulation. Nearest neighbour search. KD-tree. Convex hull. Voronoi diagram. Maps. Point cloud registration. Hough transform. Random Sample Consensus (RANSAC). Application of computer vision in robotics. Perception sensors - camera, 3D camera, stereo vision, LIDAR. Image filtering. Edge and key point detection. Image and 3D point cloud segmentation. Optical flow. Camera calibration. Estimating camera pose relative to the operating environment of a robot. Multiple view reconstruction of a three-dimensional object and scene. Map building using computer vision. Place recognition. Obstacle detection. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3,4,5,6 | Lectures, Laboratory exercises | | 3 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 0.6 | 3,4,5,6 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 5 | 20 |
| Oral exam | 1.2 | 1,2,6 | Oral exam | Assessment of student's answers | 20 | 40 |
| Problem-solving related to design exercises | 1.2 | 3,4,5,6 | Design exercises (KV) | Evaluation of problem solving exercises | 12 | 30 |

*1.10. Obligatory literature*

1 Bradski, G.; Kaehler, A. Learning OpenCV O Reilly, 2008

*1.11. Recommended additional literature*

1 E. R. Davies Machine Vision: Theory, Algorithms, Practicalities, 3rd edition Elsevier, San Francisco, USA, 2005
2 R. Hartley, A. Zisserman Multiple View Geometry in Computer Vision Cambridge University Press, 2003.
3 O. Faugeras Three-Dimensional Computer Vision: A Geometric Viewpoint Cambridge, Massachusetts: The MIT Press, 1993.
4 R. Cupec Osnove inteligentnih robotskih sustava, udžbenik u izradi Zavod za računalno inženjerstvo i automatiku, ETF Osijek, 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).

| General information | | |
|---|---|---|
| Lecturer | Prof.dr.sc. MARTINOVIĆ GORAN | |
| Course name | DR2-01 Real-time Computer Systems | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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* |
| Explain [to students] time, functional and other important constraints in applications of recent computer systems. Present properties and utilisation of adequate methodologies, hardware and software tools that enable performance improvements of embedded and distributed computer systems. |
| *1.2. Conditions for enrollment* |
| Requirements met for enrolling in the study programme |
| *1.3. Learning outcomes* |
| 1.understand time, functional and other features relevant to computer systems for real-time operation<br>2.evaluate environment-related requirements as well as hardware and software properties of computer systems to model and create a real-time operation system<br>3.apply the defined hardware and software methodologies, algorithms and development environments to hardware and software realisation of real-time computer systems<br>4.create hardware and software solutions for real-time computer systems by using the aforementioned hardware and software methodologies, algorithms and development environments<br>5.measure, test and compare solutions in embedded, distributed and omnipresent cyber-physical systems<br>6.analyse and modify the implemented [system] solutions with the aim of improving performance |
| *1.4. Course content* |
| Computer systems according to time constraints. Meta-functional requirements. Time, time bases and constraints in measuring time. System modelling: task, time and event driven systems, interrupts. Resource management (scheduling), algorithm complexity and performance measures. Communication and synchronisation. Adaptation of operating systems for real-time requirements. Required properties of software tools for realising systems. Access to system components from high-level programming languages. Programming languages for realising real-time computer systems. Analysis of a software code for the worst-case execution times (WCET). Interfaces between systems and environments. Creation of a real-time system: specifications, design, analysis and testing of control, communication, multimedia and specific application settings. Signal processing (DSP). Embedded distributed and omnipresent computer systems (open and single-board hardware platforms and |

programming environments: Arduino, Raspberry Pi, Cubieboard). Autonomous computer systems. Internet of things (IoT). Cyber-physical systems.

| | |
|---|---|
| *1.5. Teaching methods* | Lecture<br>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 | 1.3 | 1,2,3,4,5,6 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 3 | 6 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1.2 | 3,4,5,6 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 0 | 18 |
| Oral exam | 1 | 1,2,3 | Oral exam | Assessment of student's answers | 15 | 30 |
| Writen exam and computer solving software, simulation and modeling tasks | 1.5 | 3,5,6 | Written exam | Exercise evaluation | 15 | 30 |
| Writing a seminar paper and realising a project assignment. | 1.5 | 3,4,5,6 | Course report. | Evaluation of a seminar paper | 3 | 6 |
| Preparation for answering course related questions in a written form | 0.5 | 1,2,3,6 | Written exam. | Knowledge assessment (written exam | 5 | 10 |

*1.10. Obligatory literature*

1 Laplante, P; Ovaska, S.J. Real-Time Systems Design and Analysis: Tools for Practitioner Wiley-IEEE Press, 2011.

*1.11. Recommended additional literature*

1 G.C. Buttazzo Hard Real-Time Computing Systems: Predictable Scheduling Algorithms and Applications Springer, 2011.
2 M. Qiu, J. Li Real-Time Embedded Systems: Optimization, Synthesis, Networking CRC Press, 2011.
3 M.T. Higuera-Toledano, A.J. Wellings Distributed, Embedded and Real-time Java Systems Springer, 2012.
4 A. Burns, A. Wellings Real Time Systems and Programming Languages: Ada 95, Real-Time Java and Real-Time C/POSIX (3rd Ed.) Addison Wesley, 2001.

5 A.C. Shaw Real-Time Systems and Software John Wiley & Sons, 2001.
6 H. Kopetz Real-Time Systems Design Principles for Distributed Embedded Applications Springer, 2013.
7 A. McEwen, H. Cassimally Designing the Internet of Things Wiley, 2013.
8 F. Hu Cyber-Physical Systems: Integrated Computing and Engineering Design CRC Press, 2013.
9 J.W.S. Liu Real-Time Systems Prentice Hall, 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 | Prof.dr.sc. MARTINOVIĆ GORAN | |
| Course name | DRcd1-06-18 Service Computing and Big Data | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory) | |
| Course status | Mandatory | |
| Year of study | 1 | |
| ECTS credits and teaching methods | ECTS credits | 6 |
| | Workload (L+(AE+LE+CE)+S) | 30+(0+30+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Explain [to students] the architectures and principles of service-oriented computing and cloud computing. Introduce students to the requirements and methods for data discovery and analysis. Present the utilisation of service environments, tools, and programming technologies for data analysis in business, research, industry and other application domains. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.understand the architecture and principles of service-oriented computing, transport data formats as well as requirements and methods of data analysis in the service environment<br>2.evaluate the machine learning methods and models to create enhanced algorithmic and software solutions tailored to the service environment<br>3.create the required architecture of service systems as well as methods and programme methodologies for big data analysis<br>4.apply the defined architecture of service-oriented computing, approaches and software for data analysis to data obtained from different sources<br>5.examine the efficiency and applicability of the service-computing environment, methods and programming solutions for a different source data analysis<br>6.analyse and modify implemented solutions with the aim of improving performance of service-oriented systems with applications | |
| *1.4. Course content* | |
| Service based distributed computing. Service management types and means. Cloud computing. Cloud computing architecture. Defining a platform, infrastructure, application and presentation. User management, reliability, security, authorisation, authentication. Transport formats (XML, JSON). Advanced RESTful web services. Development, testing, placing a service on the market. Implementation properties and the possibility of utilising public clouds (Microsoft Azure, Amazon Web Services, Google App Engine). Big data discovery, storage, handling and processing technologies. Non-relational data, NoSQL and the appropriate technologies. ETL approach. Application of selected statistical and machine learning procedures. Analytical, implementation and learning technologies/tools: R basics, MapReduce, Hadoop, Pig, Hive, Mahout, Azure Machine Learning. Big data analytics in real time. Application in business, scientific and industrial environments, user experiences. Project assignments in cooperation with partner companies. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3,4,5,6 | Lectures, Laboratory exercises | | 3 | 6 |
| 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 | 12 | 24 |
| Oral exam | 1 | 1,2,3 | Oral exam | Assessment of student's answers | 15 | 30 |
| Solving theoretical, problematic, modeling and programming tasks | 1.5 | 2,3,6 | Written exam | Checking solutions during a written exam and laboratory exercise reports | 10 | 20 |
| Project asignment | 1 | 3,4,5,6 | Practical work | Grading a project assignment | 10 | 20 |

*1.10. Obligatory literature*

1 Kavis, M.J. Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS) Wiley, 2014.

*1.11. Recommended additional literature*

1 J. Rhoton, R. Haukioja Cloud Computing Explained: Implementation Handbook for Enterprises (2nd Ed.) Recursive Press, 2009.
2 B. Baesens Analytics in a Big Data World: The Essential Guide to Data Science and its Applications Wiley, 2014.
3 B. Ellis Real-Time Analytics: Techniques to Analyze and Visualize Streaming Data Wiley, 2014.
4 EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data Wiley, 2015.
5 N. Zumel Practical Data Science with R (1st Ed.) Manning Publications, 2014.
6 F. Provost, T. Fawcett Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking O Reilly Media, 2013.
7 V. Mosco To the Cloud: Big Data in a Turbulent World Paradigm Publishers, 2014.
8 A. Holmes Hadoop in Practice (2nd Ed.) Manning Publications, 2014.
9 M. Barlow Real-Time Big Data Analytics: Emerging Architecture O Reilly, 2013.

*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. CUPEC ROBERT | |
| Course name | DR4I-07 Robot Vision | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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+0)+0 |

| 1. Course description |
|---|
| *1.1. Goals* |
| Gain basic knowledge from the field of computer vision. Provide an insight into possibilities of application of computer vision for object recognition, robot manipulation and localisation of autonomous mobile systems. Make students understand the basic principles of modern computer vision methods, and teach them to apply these methods for solving technical problems, which require object recognition, robot manipulation and localisation of autonomous mobile systems. Learn how to develop computer programmes based on computer vision. |
| *1.2. Conditions for enrollment* |
| Requirements met for enrolling in the second year of the study programme |
| *1.3. Learning outcomes* |
| 1.create a computer programme which uses the Hough transformation and RANSAC algorithm for solving computer vision problems<br>2.create a computer programme for recognition of 2D and 3D objects in an image acquired by a standard and 3D camera<br>3.to perform the calibration of a camera and a stereo camera system<br>4.combine programme components for creating 3D models of objects and scenes from two or multiple images acquired by a standard and 3D camera into a computer application<br>5.to explain how a mobile robot can localize itself in an operating environment using computer vision<br>6.create a computer program which implements basic computer vision methods using appropriate program libraries for computer vision |
| *1.4. Course content* |
| Introduction to robot vision: basic terms, application of computer vision in robotics, examples. Image filtering. Edge and corner detection. Hough transform. Recognition of two- and three-dimensional objects. Camera model. Camera calibration. Stereo vision. Optical flow. Estimating camera pose relative to the operating environment of a robot. Multiple view of a three-dimensional object and scene reconstruction. Fusion of measurement data obtained by sensors of different types. Environment map building using data obtained by a vision system. Uncertainty of vision-based measurement. Application of computer vision methods for manipulation with objects in robotised production systems and navigation of mobile robots in their |

operating environments. 3D cameras. Segmentation of range images and 3D point clouds. Object recognition and pose estimation using a 3D camera.

| | |
|---|---|
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3,4,5 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 25%. | 3 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 0.6 | 1,2,3,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 5 | 20 |
| Oral exam | 1.2 | 1,2,3,4,5 | Oral exam | Assessment of student's answers | 20 | 40 |
| Seminar paper | 1.2 | 2,4,5,6 | Development of a computer program and testing its functionality | Testing the functionality of a developed computer program, knowledge assessment, reports grading | 12 | 30 |

*1.10. Obligatory literature*

1 Bradski, G.; Kaehler, A. Learning OpenCV O Reilly, 2008

*1.11. Recommended additional literature*

1 E. R. Davies Machine Vision: Theory, Algorithms, Practicalities, 3rd edition Elsevier, San Francisco, USA, 2005
2 R. Hartley, A. Zisserman Multiple View Geometry in Computer Vision Cambridge University Press, 2003.
3 O. Faugeras Three-Dimensional Computer Vision: A Geometric Viewpoint Cambridge, Massachusetts: The MIT Press, 1993.
4 R. Cupec Osnove inteligentnih robotskih sustava, udžbenik u izradi Zavod za računalno inženjerstvo i automatiku, ETF Osijek, 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).

| General information | | |
|---|---|---|
| Lecturer | Izv. prof. dr. sc. BAUMGARTNER ALFONZO | |
| Course name | DRcd1-04 System Programming | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (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* | |
| Introduce students with the capabilities and limitations of operating systems, as well as user and environment requirements. Introduce students with the development of moderately complex and effective system and application software projects with the help of modern programme principles and tools. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.describe and use Windows API for file, memory and process management<br>2.solve complex problems with threads and use synchronisation mechanisms along with reliable multithreading models<br>3.use interprocess communication and implement ways of network communication<br>4.design system programmes which use asynchronous I/O and explain novelties in Win64 API<br>5.write system programmes which use Win32 API | |
| *1.4. Course content* | |
| Requirements on system and application software. Analysis of modern operating systems (Unix, Linux, Windows) in different complexity environments. Design of simple drivers and applications. Basic programming techniques. File and directory control. Control of input-output units and ports. Security services. Memory management. Dll files. Exceptions handling. Processes and threads in programmes: events and exclusion, multithreading. Signals. Interprocess communication: pipes and messages. Fundamentals of network programming: sockets. Design of system software in embedded systems and design of some Win32 and Win64 services. Graphical user interface: windows, controls. Timing function programming. System monitoring and measurement programmes. Approaches and models that enable an increase and evaluation of system performance. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3,4,5 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 5 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 2,3,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 12 | 30 |
| Oral exam | 1.8 | 1,2,3,4,5 | Oral exam | Assessment of student's answers | 20 | 40 |
| Online short quiz on Loomen | 1.2 | 1,2,3,4 | Online quiz in Loomen | Automatic solution checking | 0 | 20 |

*1.10. Obligatory literature*

1 Hart, J.M. Windows System Programming (3rd Ed.) Boston: Addison Wesley Professional, 2004.

*1.11. Recommended additional literature*

1 A.S. Tanenbaum Modern Operating Systems (2nd Ed.) Prentice Hall, Englewood Clifs, NJ, 2001.
2 Microsoft Windows Team Staff Microsoft Windows XP Professional Resource Kit Microsoft Press, 2003.
3 R. Grehan, R. Moote, I. Cyliax Real-Time Programming: A Guide to 32-bit Embedded Development Addison Wesley, New York, NY, 1999.
4 D. Vandevoorde, N.M. Josuttis C++ Templates: The Complete Guide Addison-Wesley Professional, Boston, NY, 2002.
5 M.E. Russinovich, D.A. Solomon Microsoft Windows Internals (4th Ed.): Microsoft Windows Server(TM) 2003, Windows XP, and Windows 2000 Microsoft Press, 2004.
6 K.A. Robbins, S. Robbins Unix Systems Programming: Communication, Concurrency and Threads Prentice Hall, Indianapolis, IN, 2003.
7 S. Walther Sams Teach Yourself Visual Studio.NET in 21 Days Sams, Indianapolis, IN, 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 | Doc. dr. sc. ALEKSI IVAN | |
| Course name | DR4I-08 Sonar computing | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Introduce students to the basics of sonar system design and skills to reconstruct the surface and image of underwater objects using the sonar signal. Introduce procedures for displaying signal spectrum, digital filtering of 1D and 2D sonar signals, creating 2D and 3D submarine images, designing an antenna or transceiver field, displaying antenna radiation, emitting and wave simulation, sonar image processing, and submarine mining in sonar images. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the second year of the study programme | |
| *1.3. Learning outcomes* | |
| 1.define and explain the characteristics of the sonar and its environment<br>2.describe methods of digital signal processing sonar<br>3.create a software solution for creating images using sonar<br>4.validate and compare different methods and sonar models<br>5.develop and apply different methods and models of sonar in the MATLAB and C ++ programming environment | |
| *1.4. Course content* | |
| Mathematical models of underwater media for wave transmission. Diffusion simulation of wave transmission and sampling. Transformation of coordinates between coordinates of the environment, sonar and diver. Application of 3D computer models for simulation of underwater reconstruction. Computer models of hulls and naval ports. Simulation of hull reconstruction. Algorithms for creating 2D and 3D underwater images by changing the sonar system. Calculating linear field radiation graphs of underwater transmitters. Digital FIR filters for bandwidth limited signal. Filtering methods 1D and 2D sonar signals. Quadrature demodulation procedures. Methods of forming antenna air in the time and frequency domain. Calculate distance of objects in close and far field. View the environment using point clouds. The colouring of point clouds by intensity and distance. Orthographic projection of 3D clouds of points on a 2D image. Sonar for detecting underwater mines. Segmentation of objects in sonar images. Segmentation of underwater mine in sonar images. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1.5 | 1,2,3,4,5 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 0 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 3,4,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 0 | 25 |
| Oral exam | 1.5 | 1,2,4 | Oral exam | Assessment of student's answers | 25 | 50 |
| Seminar paper | 1 | 1,2,3,4,5 | Seminar paper | Evaluation of exercises | 10 | 15 |

*1.10. Obligatory literature*

1 A.D.Waite SONAR for Practicing Engineers, Third edition John Wiley & Sons, Ltd. 2002, ISBN10: 0-471-49750-9.

*1.11. Recommended additional literature*

1 Uvais Qidwai and C.H. Chen Digital Image Processing, An Algorithmic Approach With MATLAB Chapman & Hall, 2010. ISBN13: 978-1-4200-7950-0.
2 E. Oran Brigham The Fast Fourier Transform And Its Applications Prentice Hall, 1988. ISBN10: 0-13-307505-2.
3 Zdenko Kovačić, Stjepan Bogdan, Vesna Krajči Osnove robotike Graphis, Zagreb, 2002. ISBN10: 953-6647-29-X.
4 William S. Burdic Underwater Acoustic System Analysis Prentice Hall, 1984. ISBN10: 0-13-936716-0.
5 Philippe Blondel The Handbook of Sidescan SONAR Springer-Praxis Publisching, 2009. ISBN13: 978-3-540-42641-7.

*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. KESER TOMISLAV, Izv. prof. dr.sc. JOB JOSIP | |
| Course name | DR3-04 Practical Training in Computing | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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.identify the organizational structure of the production-business system as well as the tasks and role of the managers in them<br>2.identify engineering tasks as well as the necessary knowledge and skills related to manufacturing technology in the company<br>3.get acquainted and evaluate workplace safety measures and procedures in a working environment<br>4.list the most important regulations and standards related to manufacturing technology in the company<br>5.master professional written expression and technical documentation skills for communication in engineering |
| *1.4. Course content* |
| Professional training is done by students for a period of 200 hours (13 working hours per week on average). Each student realises an internship in a company doing jobs in the field. A student, guided by a tutor, learns about the organisational structure of the production, business system with production technology and occupational safety and is involved in engineering work respecting the protection measures, professional and technological rules as well as other company rules. During practical training, a student keeps a work record. Professional training is organised by the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek in cooperation with engineers employed in companies whose activity is in the field of electrical engineering. These engineers are appointed by the Faculty and they jointly create and coordinate practical work of students in companies. Organisation of practical training is regulated by the Manual on practical training of |

students enrolled in the professional study programme at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek.

| | |
|---|---|
| *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<br>, Design exercises | 6.5 | 1,2,3,4 | , Design exercises | Attendance register. Mandatory attendance percentage is: 70%. | 32 | 40 |

*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. MATIĆ TOMISLAV (ml.) | |
| Course name | DRa2-03-18 Ubiquitous computing | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (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* | |
| Present theoretical and practical knowledge in the field of ubiquitous computing to students. Teach students to identify specific problems in the field of ubiquitous computing. Enable students to analyse and develop hardware and software for computer systems in the field of ubiquitous computing. | |
| *1.2. Conditions for enrollment* | |
| Requirements for the enrolment in the graduate university study programme Computer Engineering. | |
| *1.3. Learning outcomes* | |
| 1.explain the basic concepts of ubiquitous computing<br>2.identify specific problems in the field of ubiquitous computing<br>3.analyse requirements for the set application<br>4.develop hardware<br>5.develop software<br>6.test the system operation in the set environment | |
| *1.4. Course content* | |
| Introduction. Basic concepts of ubiquitous computing. Requirements of ubiquitous computing. Computer system interfaces. Autonomous systems. Smart devices. Communication. Localisation. Examples of computer systems. The future of ubiquitous computing. | |
| *1.5. Teaching methods* | Lecture<br>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 | | Teaching method | Assessment method | Points |
|---|---|---|---|---|---|

| | | Learning outcomes | | | Min | max |
|---|---|---|---|---|---|---|
| Attendance Lectures, Laboratory exercises | 2 | 1,2,3,4,5 | Lectures, Laboratory exercises | | 5 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 2 | 2,4,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 15 | 50 |
| Oral exam | 1 | 1,2,3,4 | Oral exam | Assessment of student's answers | 20 | 40 |

*1.10. Obligatory literature*

1 Natalia Silvis-Cividjian Pervasive Computing: Engineering Smart Systems Springer; 1st ed. 2017.
2 Stefan Poslad Ubiquitous Computing: Smart Devices, Environments and Interactions John Wiley & Sons Inc, 2009.

*1.11. Recommended additional literature*

1 John Krumm Ubiquitous Computing Fundamentals CRC Preess 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. KESER TOMISLAV | |
| Course name | DARab2-04-17 Embedded Computer Systems | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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<br>2.explain application properties of a microprocessor, micro-controller and DSP in embedded applications<br>3.define and evaluate requirements, and choose an embedded computer system based upon application requirements<br>4.analyse and evaluate the applicability of an embedded real-time computer system<br>5.design software support according to application requirements<br>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<br>Auditory exercises<br>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: 25%. | 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).

| General information | | |
|---|---|---|
| Lecturer | Prof.dr.sc. CUPEC ROBERT | |
| Course name | DRab1-02 Control of Dynamic Systems | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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* | |
| Upgrade the students' knowledge on automatic control, gained in the undergraduate study programme, with knowledge about methods of a state space control system analysis and design and complex control system structures. Teach students how to define a simple mathematical process model and draw conclusions about its dynamical properties. Explain the basics of process identification. Teach students how to write a basic computer programme for digital controller implementation. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.formulate state space process models<br>2.apply a process identification software to obtain process models<br>3.design digital polynomial controllers using the pole placement approach<br>4.design digital state space controllers<br>5.integrate basic control elements into more complex control structures such as feedforward control, cascade control, multivariable control and predictive control<br>6.explain the basic principle and structure of adaptive control systems<br>7.write a simple computer programme realisation of a digital controlle | |
| *1.4. Course content* | |
| State-space representation. Pole placement controller design. Basics of process modelling by a theoretical analysis and measurement of process variables. Controller design using root locus. Feedforward control. Cascade control. Control of multivariable systems. Discrete control systems. Design of discrete controllers. Implementation aspects of PID controller. Controller implementation by a computer programme. Control of processes with dead time. Predictive control. State-space design of linear discrete controllers. State estimators. Basics of process identification. Basic structures of adaptive control systems. Optimal control. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3,4,5,6 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 7 | 10 |
| Practice – problem solving | 1.5 | 1,3,6 | Midterm exam | Evaluation of (written) exercises | 15 | 30 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 2.5 | 2,3,4,7 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 20 | 50 |
| Oral exam | 2 | 1,3,4,5,6 | Oral exam | Assessment of student's answers | 20 | 40 |

*1.10. Obligatory literature*

1 J. ström, B. Wittemark Adaptive Control Dover Publications inc, New York, 2008

*1.11. Recommended additional literature*

1 T. Šurina Automatska regulacija Školska knjiga, Zagreb, 1991.
2 Z. Kovačić, S. Bogdan, V. Krajči Osnove robotike Graphis Zagreb, 2002.
3 Z. Vukić, Lj. Kuljača Automatsko upravljanje: analiza linearnih sustava Kigen, Zagreb, 2005.
4 J. ström, B. Wittemark Computer Controlled Systems: Theory and Design New Jersey, Prentice-Hall, 1997
5 N. Perić Automatsko upravljanje - predavanja Zavodska skripta, FER, Zagreb, 2004.
6 N. Perić, I. Petrović Automatizacija postrojenja i procesa - predavanja Zavodska skripta, FER, Zagreb, 2002.
7 R. Cupec Diskretni sustavi upravljanja, nastavni materijali Zavod za industrijska postrojenja i automatizaciju, ETF Osijek, 2010.
8 R. Cupec Sinteza digitalnog regulatora metodom postavljanja polova Zavod za industrijska postrojenja i automatizaciju, ETF Osijek, 2012.
9 N. Perić, D. Slišković Identifikacija procesa, nastavni materijali Zavod za industrijska postrojenja i automatizaciju, ETF Osijek, 2009

*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. MAJSTOROVIĆ VLADO | |
| Course name | D4-02 Project Management | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (mandatory) | |
| Course status | Mandatory | |
| Year of study | 2 | |
| ECTS credits and teaching methods | ECTS credits | 5 |
| | Workload (L+(AE+LE+CE)+S) | 30+(15+0+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Students will gain knowledge on formal definition of a project, ways of its initiation and progress, team work and formal tracking of project progress through processes and areas within the project management system. Students will become qualified for application of methodology in practice and design of project plans in the respective area. Furthermore, students will become acquainted with computer support for project design and management. | |
| *1.2. Conditions for enrollment* | |
| The necessary requirements to enrol in the second year of the studies. | |
| *1.3. Learning outcomes* | |
| 1.define, distinguish between and link the basic concepts related to the field of organisation and project management<br>2.define and link strategy to project goals<br>3.identify and connect the basic processes and areas in project management<br>4.analyse, evaluate and propose appropriate tools and project planning techniques<br>5.propose a project planning methodology for a practical example and create a project plan<br>6.analyse and rank various project management software | |
| *1.4. Course content* | |
| Definition of project and project management. Project strategy and management. Project life â€“ cycle, direct project participants and other stakeholders in the project. Appropriate project organisation. Basic processes of project management: initiation, planning, implementation, surveillance and control, inference. Techniques and tools for project management. Areas of project management: integrations project management, management of project volume, management of project time, expenses and quality, human resources management, project communication management, project risk management, project acquisition management. Techniques of project planning. Computer support of project management. Tools for project management support. Standard project documentation. Evaluation and documenting of experiences. | |
| *1.5. Teaching methods* | Lecture<br>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: 50%. | 0 | 0 |
| Practice – problem solving | 1.3 | 4,5 | Midterm exam | Evaluation of (written) exercises | 25 | 50 |
| Oral exam | 1.2 | 1,2,3,4 | Oral exam | Assessment of student's answers | 15 | 30 |
| Project task development | 1 | 4,5,6 | Self-development of a project assignment with mentorship of teachers | Evaluation of a project assignment | 10 | 20 |

*1.10. Obligatory literature*

1 Majstorovic, V. Projektni menadžment Sveučilište u Mostaru, 2010.
2 A Guide to the Project Management Body of Knowledge (PMBOK Guide) PMI, 2010.

*1.11. Recommended additional literature*

1 D. Satterson, J. Henessey Computer Organization and Design: The Hardware/Software Interface (2nd Edition) Morgan Kaufmann Publ., San Francisco, 1997.
2 A. S. Tanenbaum Structured Computer Organization, 7th ed. Prentice-Hall, New Jersey, 2005.
3 H. Kerzner Project Management Case Studies Willey, 2004.

*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. JOB JOSIP | |
| Course name | DRcd2-03 Data visualization | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (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* | |
| Introduce students to theoretical and practical knowledge in the field of data visualisation. Teach them how to use and to work with data visualisation tools and libraries. Train them to work individually and within team on data visualisation projects, and enable critical thinking and evaluation of data visualisation. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the study programme | |
| *1.3. Learning outcomes* | |
| 1.indicate and describe the basic elements of visualization<br>2.design and create one's own data visualisation using appropriate tools and software libraries<br>3.propose design of data visualisation in line with good practice and in accordance with the theoretical basis<br>4.interpret and analyse data visualization design | |
| *1.4. Course content* | |
| Introduction to data visualisation, importance of data visualisation: storage of information, decision support, information transfer. Data types. Nominal, ordinal and quantitative data. Dimensions and measures. Visual encoding variables. Data visualisation reference model. Data visualisation design. Data analysis. Visualisation of multidimensional data. Perception, human visual system, Gestalt psychology. Interaction. Animation. Cartography. Graphs and trees. Colours. Narrative visualisation. Text visualisation. Evaluation of data visualisation. Data visualisation tools. | |
| *1.5. Teaching methods* | Lecture<br>Laboratory exercises<br>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 | 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 | 0.5 | 2 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 5 | 10 |
| Oral exam | 1 | 4 | Oral exam | Assessment of student's answers | 20 | 40 |
| Problem-solving related to design exercises | 0.5 | 3 | Design exercises | Evaluation of problem solving exercises | 5 | 10 |
| Project | 2 | 2,3 | Presenting a seminar paper | Evaluation of problem solving exercises | 15 | 30 |

*1.10. Obligatory literature*

1 E. R. Tufte The Visual Display of Quantitative Information, 2nd edition Graphics Press, Cheshire, 2001.
2 Murray, S. Interactive Data Visualization for the Web O Reilly, 2013.

*1.11. Recommended additional literature*

1 M. Maclean D3 Tips & Tricks M. Maclean, 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).

| General information | | |
|---|---|---|
| Lecturer | Izv. prof. dr. sc. NENADIĆ KREŠIMIR | |
| Course name | DRcdKb2-02-18 Web Programming | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (mandatory)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (mandatory) | |
| Course status | Mandatory | |
| Year of study | 1 | |
| ECTS credits and teaching methods | ECTS credits | 7 |
| | Workload (L+(AE+LE+CE)+S) | 45+(15+15+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| - | |
| *1.2. Conditions for enrollment* | |
| Requirements for the enrolment in the graduate university study programme in Computer Engineering or Electrical Engineering. | |
| *1.3. Learning outcomes* | |
| 1.compare different technologies and use them to create web content (website)<br>2.identify client and server technologies and select appropriate technologies to solve a specific problem in the form of a website<br>3.choose the appropriate way of accessing the database over the web, develop website with client and server functionality<br>4.analyse and solve a specific problem combining different web programming technologies and suggest possible expansions for the solved task | |
| *1.4. Course content* | |
| Process of creating web documents. Client-side technologies - HTML (syntax, standard structure, hypertext, forms). Cascading style sheets (CSS). JavaScript basics, JavaScript and HTML, dynamic documents with JavaScript. Differences between HTML and XML. Server-side technologies - PHP, ASP and ASP.NET, cookies, session, PHP/MySQL. Web portal development. Development of web applications. | |
| *1.5. Teaching methods* | Lecture<br>Auditory exercises<br>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 | Lectures, Auditory exercises, Laboratory exercises | | 0 | 20 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 1,2,3,4 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 15 | 20 |
| Oral exam | 2.8 | 1,2,3,4 | Oral exam | Assessment of student's answers | 15 | 30 |
| Active class participation, problem solving | 1.7 | 1,2,3,4 | Individuall work | Assessing the project task functionality | 20 | 30 |

*1.10. Obligatory literature*

1 Lukić, Ivica; Köhler, Mirko Osnove Internet programiranja 2011.
2 Sebesta, R.W. Programming the World Wide Web (2nd Ed.) Boston: Addison-Wesley, MA, 2004.

*1.11. Recommended additional literature*

1 T. Powell, Thomas Web Design: The Complete Reference Berkeley, Osborne/McGraw-Hill, NY, 2000.
2 M. Hall, L. Brown Core Web programming, A Sun Microsystems Press/Prentice Hall PTR Book, New York, NY, 2001.
3 K. Kalata Internet Programming Thompson Learning, London, 2001.
4 F. Halsall Computer Networking and the Internet (5th Ed.) Addison-Wesley, Boston, MA, 2005.
5 H. Deitel, P. Deitel, T. Nieto, K. Steinbuhler The Complete Wireless Internet and Mobile Business Programming Training Course Prentice Hall, New York, NY, 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 | Doc.dr.sc. KRPIĆ ZDRAVKO | |
| Course name | DKR4I-04 Green Computing | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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+0)+0 |

| 1. Course description | |
|---|---|
| *1.1. Goals* | |
| Enable students to become familiar with and include them in the processes of development, improvement and application of the environmentally friendly computing technologies. Demonstrate to students the scope and amount of impact of computer systems on the environment and present them ways to recognize the potential of green progress in computing technologies. Provide students with current knowledge of (energy) efficient hardware and software technologies. | |
| *1.2. Conditions for enrollment* | |
| Requirements met for enrolling in the second year of the study programme | |
| *1.3. Learning outcomes* | |
| 1.identify and understand the environmental impact of the computing<br>2.evaluate energy acceptability of a computer system by using appropriate metrics and tools<br>3.design and independently create software solutions using frequency and voltage scaling and throttling of hardware processing capabilities<br>4.apply dynamic voltage and frequency scaling technology and hardware performance throttling in software development<br>5.assess potential omissions in energy efficiency of the existing computer systems | |
| *1.4. Course content* | |
| Introduction to the impact of computing on the environment. Evaluating energy efficiency of computer systems. Designing sustainable computer systems. Application layers of green technologies in computing. Basics of computer hardware. Green hardware technologies in computing. Frequency and voltage scaling of processing units. Throttling processing capabilities of computing hardware units. Other technologies for reducing the impact of computer hardware on the environment. Distributed and parallel computing. Programming technologies for reducing an energy footprint. Energy conscious models of software. Energy aware software paradigms. Implementation of energy saving technologies on a software level. Energy aware operating systems. Low-energy computer systems: SoC and MPSoC. Technology of installation and cooling of data and processing centres. Combining green technologies into ready-made solutions. | |
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3,4,5 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 70%. | 8 | 10 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1 | 2,3,4,5 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 10 | 20 |
| Oral exam | 1 | 1,2,3,4,5,6 | Oral exam | Assessment of student's answers | 15 | 30 |
| Research, analysis and report writing, team work | 1 | 2,3,5,6 | Presenting a seminar paper | Analysis of the seminal paper, assessing the amount of work as a team member | 10 | 20 |
| Solving tasks and answering questions | 1 | 1,2,3,5,6 | Midterm exams (written exam) | Analysis and checking of the assignment and answers to questions | 10 | 20 |

*1.10. Obligatory literature*

1 Ahmad, Ishfaq ; Ranka, Sanjay Handbook of Energy-Aware and Green Computing - Two Volume Set Chapman & Hall/CRC Computer and Information Science Series, 2012., Florida, SAD

*1.11. Recommended additional literature*

1 Hu, Wen-Chen, ed. Sustainable ICTs and management systems for green computing IGI Global, 2012.
2 Albert Y. Zomaya, Young Choon Lee Energy Efficient Distributed Computing Systems (1st ed.) Wiley-IEEE Computer Society Pr. 2012.
3 Martinović, Goran; Krpić, Zdravko Towards Green HPC Blueprints Proceedings of the Second International Conference on Cloud Computing, GRIDs, and Virtualization, Ri
4 Gruber, Ralf, Vincent Keller HPC@green It: Green High Performance Computing Methods Berlin: Springer-Verlag, 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 | Doc. dr. sc. ALEKSI IVAN | |
| Course name | DR4I-09 Chess and Computers | |
| Study program | Graduate study programme, branch: Computer Engineering, elective block Information and data science (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Software Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Computer Engineering (elective)<br>Graduate study programme, branch: Computer Engineering, elective block Robotics and artificial intelligence (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+0)+0 |

| 1. Course description |
|---|
| *1.1. Goals* |
| Show students specific problems in the field of chess, algorithms and computer programming. Introduce students to tools to create computing applications and deploy simple and complex computer algorithms. Introduce methods for generating moves, position reviews, logical decision-making, match players at tournaments, ELO score calculations, and computer PGN chess file format. |
| *1.2. Conditions for enrollment* |
| Requirements met for enrolling in the second year of the study programme |
| *1.3. Learning outcomes* |
| 1.define, recognize and describe the strengths and weaknesses of the chess position<br>2.distinguish, explain and compare the work of individual parts of a chess computer program<br>3.evaluate and assess performance of different chess engines<br>4.develop and demonstrate simple computer applications with chess applications<br>5.apply and test simple chess applications<br>6.evaluate performance of developed and open source chess engines |
| *1.4. Course content* |
| Game rules. Creating an application to retrieve feasible chess moves. Create an application with PGN (Portable Game Notation) format of a chess file. Digital chess clock and creating a chess clock application. Creating an application to match players in a tournament according to the Berger and Swiss system. Chess titles and their assignment. ELO rating. Creating an application for calculating chess rating based on a mathematical model of a player. Learning advanced chess game elements. Tactics and strategy in chess. Chess Opening, Centre and Finish. Learning how a computer plays chess. Generating moves. Cost function. Search graph with iterative depth increase. Hash table. Key features of Deep-Blue and ChessBase software. Bitboard position record mode. Presentation of chess with a graph. Learning and applying a min-max decision-making algorithm during a chess game. Heuristic and exact approach. Creating an application with artificial intelligence for a chess game play. Obtaining general knowledge about a chess game. Application of MATLAB, C ++, C# and Visual Basic programming languages for creating simple and complex chess applications. |

| | |
|---|---|
| *1.5. Teaching methods* | Lecture<br>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 | 1,2,3 | Lectures, Laboratory exercises | Attendance register. Mandatory attendance percentage is: 50%. | 0 | 0 |
| Writing pre-lab write-ups, results analysis and writing laboratory reports | 1.1 | 2,3,4,5,6 | Laboratory practice | Assessment of pre-lab write-ups, supervision of laboratory exercises, evaluation of written reports | 0 | 30 |
| Oral exam | 1.5 | 1,2,3,6 | Oral exam | Assessment of student's answers | 30 | 60 |
| Seminar paper | 1 | 1,2,3,4 | Oral presentation | Discussion upon presentation | 0 | 10 |

*1.10. Obligatory literature*

1 Cvetnić, Vladimir Viša škola šaha Zagreb: Alfa d.d., 2009.
2 Levy, David N. L. Monty Newborn How Computers Play Chess Ishi Press, 2009.

*1.11. Recommended additional literature*

1 Averbah, Kotov, Judovič Put ka majstrorstvu Centar za unapređivanje šaha, Beograd, 1977.
2 Reuben Fine Osnovne šahovske konačnice 1 i 2 Šahovska naklada, Zagreb 1982.
3 Robert Sedgewick, Kevin Wayne Algorithms (4th Edition) Addison-Wesley Professional; 4th edition, 2011.
4 Vladimir Vuković Uvod u šah Šahovska naklada, Zagreb, 1980.

*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).