JOSIP JURAJ STROSSMAYER UNIVERSITY OF OSIJEK
FACULTY OF ELECTRICAL ENGINEERING, COMPUTER SCIENCE AND INFORMATION TECHNOLOGY OSIJEK

Proposal for Amendments

to the Graduate University Study Programme in Electrical Engineering

Osijek, 2022

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1. INTRODUCTION

The graduate university study programme in Electrical Engineering has been carried out at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek since the academic year 2005/2006.

Taking into account the interests and the needs of the job market, the broader social community, student interests, as well as scientific promotion of staff who could participate in the teaching process, we have decided to propose amendments to the study programme.

With these amendments, students who enrol in the graduate university study programme in Electrical Engineering would be able to opt for one of the following three branches, and a separate admission quota will be defined for each of these three branches:
EE – Power Engineering
AIS – Industrial Automation
KI – Communications and Informatics

1.1. Basic information about the higher education institution (name and address of the higher education institution, phone number, email address, web address).

Name of the higher education institution:
Josip Juraj Strossmayer University of Osijek
Faculty of Electrical Engineering, Computer Science and Information Technology Osijek
Address:
Kneza Trpimira 2b
31 000 Osijek

Phone:
+385 31 224 600

Email address:
ferit@ferit.hr

Web address:
http://www.ferit.unios.hr

1.2. Name of the body that authorised the launch of the amendments to the study programme (e.g. management boards, teachers in higher education institution councils, etc.)? Attach proof thereof.

The Faculty Council of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, Josip Juraj Strossmayer University of Osijek, adopted the "Proposal for Amendments to the Graduate University Study Programme in Electrical Engineering" at its 270th session held on 8 February 2022 (the Faculty Council decision is attached in Appendix 7.1).

1.3. List of teachers who participated in the drafting of the study programme proposal. Add their titles and scientific fields they are elected in.

Tomislav Matić, PhD, Full Professor
Technical Sciences/Electrical Engineering

Danijel Topić, PhD, Associate Professor
Technical Sciences/Electrical Engineering

Ivan Vidović, PhD, Assistant Professor
Technical Sciences/Computer Engineering

Snježana Rimac-Drlje, PhD, Full Professor
Technical Sciences/Electrical Engineering

Damir Šljivac, PhD, Full Professor
Technical Sciences/Electrical Engineering

Željko Hederić, PhD, Full Professor
Technical Sciences/Electrical Engineering

Goran Martinović, PhD, Full Professor with Tenure
Technical Sciences/Computer Engineering

Dražen Slišković, PhD, Full Professor
Technical Sciences/Fundamental Technical Sciences

Tomislav Rudec, PhD, Assistant Professor
Natural Sciences/Mathematics

Irena Galić, PhD, Associate Professor
Technical Sciences/Computer Engineering

2. INSTITUTIONAL REQUIREMENTS

2.0. The study programme proposal must contain a comparability analysis of the proposed study programme with related accredited study programmes in the Republic of Croatia and other countries in the European Union, which must contain minimum institutional requirements.

The proposed graduate university study programme in Electrical Engineering is largely based on the current graduate university study programme, which preserves the initial comparability with the quality of related accredited study programmes in the Republic of Croatia and in the European Union countries. One of the main reasons for initiating the proposed amendments to the graduate university study programme in Electrical Engineering is the implementation of the project "Application of the Croatian Qualifications Framework for University Study Programmes in the Field of Electrical Engineering – HKO-ELE", in which all those higher education institutions participate that conduct university study programmes in the field of electrical engineering in the Republic of Croatia. Within the framework of the project, four occupational standards and three qualification standards were proposed. All partner institutions participating in the project have harmonised their graduate university study programmes in the field of electrical engineering with the proposed qualification standards "Master of Electrical Engineering, branch: Power Engineering", and "Master of Information and Communication Technology, branch: Wireless Technologies". The aforementioned harmonisation of study programmes at all partner institutions (Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, Faculty of Electrical Engineering and Computing Zagreb, Faculty of Engineering Rijeka, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture Split, and University of Dubrovnik) ensured that all study programmes include all sets of compulsory learning outcomes of the proposed qualification standards, making in this way the graduate university study programme in Electrical Engineering entirely comparable to related accredited study programmes in Croatia.

The study programme is comparable in terms of content and qualifications to graduate university study programmes conducted at Croatian universities:

- **Graduate university study programme in Electrical Engineering and Information Technology at the Faculty of Electrical Engineering and Computing, University of Zagreb (https://www.fer.unizg.hr/studiji/dipl/eit). The learning outcomes of the courses in the proposed graduate study programme are largely comparable to the learning outcomes of the following courses:**
  - Power System Analysis,
  - Electricity Generation,
  - Fundamentals of Power Electronics,
  - Introduction to Smart Grids,
  - Power System Protection,
  - Synchronous and Induction Machines,
  - Economics of Power and Energy Systems,
  - Renewable Energy and Energy Storage,
  - High Voltage Technology and EMC,
  - Electric Power Distribution Systems,
  - Electrotechnical Measurements,
  - Automation of Drive Systems,
  - Electrical Drives.

- **Graduate university study programme in Information and Communication Technology at the Faculty of Electrical Engineering and Computing, University of Zagreb (https://www.fer.unizg.hr/studiji/dipl/ikt). The learning outcomes of the courses in the proposed graduate study programme are largely comparable to the learning outcomes of the following courses:**
  - Digital Signal Processing,
  - Machine Learning 1,
  - Networking Technologies,
  - Digital Communications,
  - Computer Vision,
  - Pattern Recognition,
  - Machine Vision Systems,
  - Digital Image Processing and Analysis,
  - Mobile Communications,
  - Video-Communication Technologies.

- **Graduate university study programme in Electrical Engineering at the Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split (https://www.fesb.unist.hr/studiji/diplomski-studij/elektrotehnika/). The learning outcomes of the courses in the proposed graduate study programme are largely comparable to the learning outcomes of the following courses:**
  - General Power Engineering,
  - Theoretical Electrical Engineering,
  - Measurement and Signal Processing,
  - Electric Machine Control,
  - Electromechanical System Modelling,
  - Process Measurement,
  - Industrial Automation,
  - Power System Planning,
  - Power Grids,
  - Power System Management and Control,
  - Electrical Installation Protection,
  - Engineering Economics.

- **Graduate university study programme in Communication and Information Technology at the Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split (https://www.fesb.unist.hr/studiji/diplomski-studij/komunikacijska-i-informacijska-tehnologija/). The learning outcomes of the courses in the proposed graduate study programme are largely comparable to the learning outcomes of the following courses:**
  - Digital Telecommunications,
  - Digital Television and Video,
  - Radiocommunications,
  - Numerical Methods in Communications,
  - Mobile Communications,
  - Antennas,
  - Multimedia Systems,
  - Wireless Network Security,
  - Microwave Semiconductor Circuits,
  - Artificial Intelligence,

- Software Engineering in Telecommunications.

- **Graduate university study programme in Electrical Engineering at the Faculty of Engineering, University of Rijeka (http://www.riteh.uniri.hr/obrazovanje/diplomski-sveucilisni-studij/elektrotehnika/). The learning outcomes of the courses in the proposed graduate study programme are largely comparable to the learning outcomes of the following courses:**
  - Numerical and Stochastic Mathematics,
  - Electric Drive Control,
  - Fundamentals of Robotics,
  - Electric Power Transmission and Distribution,
  - Driving and Working Machines,
  - Electrical Installation Design,
  - Digital Signal Processing,
  - Electric Power System,
  - Digital Image Processing,
  - Application of Artificial Intelligence,
  - Electricity Market,
  - Power Plants.

In addition, this study programme is comparable to graduate university study programmes carried out at European universities (for a more detailed comparison, see 3.21):

- Technical University of Kaiserslautern, study programme "Electrical and Computer Engineering": https://modhb.uni-kl.de/mhb/FB-EIT/cos-686/,
- Technical University of Wien, study programme "Electrical Engineering and Information Technology": https://www.tuwien.at/en/studies/studies/master-programmes/electrical-engineering,
- Technical University of Bremen, study programme "Electrical Engineering and Information Technology": https://www.uni-bremen.de/en/studies/orientation-application/study-programs/dbs/study/5?cHash=79d67f05dc31a010a191efd747418f45.

The study programmes are entirely comparable because they last for two years, students acquire the same number of ECTS credits (120), and the academic title Master of Electrical Engineering is entirely comparable in both the Republic of Croatia and the European Union countries. Comparability is also evidenced by successful incoming and outgoing mobility within the framework of Erasmus mobility programmes (see 3.24), which will be continued because the basic assumptions of compliance with the Bologna Process have not changed.

In addition to other teachers of the Faculty, the quality of the teaching process is ensured by a total of 58 teachers and associates affiliated to the following six departments, who will teach most of the classes:

- **Department of Software Engineering**, which consists of the Chair of Programming Languages and Systems and the Chair of Visual Computing,
- **Department of Computer Engineering and Automation**, which consists of the Chair of Computer Engineering and the Chair of Automation and Robotics,
- **Department of Core Courses**, which consists of the Chair of Mathematics, Physics and Mechanical Engineering and the Chair of Humanities and Social Sciences,
- **Department of Electromechanical Engineering**, which consists of the Chair of Fundamentals of Electrical Engineering and Measurements, the Chair of Electric Machines and Power Electronics, and the Electric Machines and Hybrid Electric Drives Laboratory,

- **Department of Communications**, which consists of the Chair of Radiocommunications and Telecommunications, the Chair of Electronics and Microelectronics, the Chair of Multimedia Systems and Digital Television, and the Laboratory for High Frequency Measurements,
- **Department of Power Engineering**, which consists of the Chair of Power Plants and Energy Processes, the Chair of Power Systems and Substations, and the Electromagnetic Compatibility Laboratory.

Most of the classes in the branches Power Engineering, Industrial Automation and Communications and Informatics will be taught by teachers affiliated with the Department of Power Engineering, the Department of Electromechanical Engineering and the Department of Communications, respectively.

Within these departments, high-quality computer, laboratory, measuring, and simulation equipment is provided in a series of teaching laboratories that have already been established and that will be used for teaching purposes. These laboratories are constantly evolving and they include the Electric Machines and Drives Laboratory, the Power Electronics Laboratory, the Electrical Measurements Laboratory, the Fundamentals of Electrical Engineering Laboratory, the Power Systems Laboratory, the Radiocommunications Laboratory, the Telecommunications Laboratory, the Renewable Energy Sources Laboratory, the Electronics and Microelectronics Laboratory, and the Physics Laboratory (see 7.2).

It should be emphasised that the Commission for Quality Enhancement and Assurance in Higher Education at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek continuously monitors student work and assessment, student surveys of the teaching process and teaching staff, as well as other action plans and ongoing activities aimed at improving the quality of education.

This comparison of the proposed graduate university study programme in Electrical Engineering leads to a conclusion that this study programme is highly comparable to related study programmes, which will certainly result in better student mobility between the University of Osijek and other Croatian universities and the majority of European universities.

2.1. Has the higher education institution adopted a strategy for its development and individual strategies or action plans, and does it disclose annual reports on their implementation?

The Strategy of Josip Juraj Strossmayer University of Osijek for the period 2021-2030 was adopted at the 2nd session of the Senate of Josip Juraj Strossmayer University of Osijek in the academic year 2021/2022, which was held on 24 November 2021.

The Development Strategy of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek for the period 2016-2020 was adopted at the 184th regular session of the Faculty Council held on 26 January 2016. The Development Strategy of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek for the period 2021-2025 is being developed and will be adopted in the coming period. The Draft Development Strategy of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek for the period 2021-2025 is harmonised with the Strategy of Josip Juraj Strossmayer University of Osijek for the period 2021-2030.

The Development Strategy, *inter alia*, consolidates individual action plans for the teaching process, scientific research, professional development activities, a quality assurance system, and resource development, and provides detailed road maps to all activities.

It is continuously monitored and analysed whether the tasks aimed at achieving the set strategic goals are fulfilled, and the Faculty Council ensures the implementation of the Strategy, *inter alia*, by adopting the plan and report submitted by the Commission for Quality Enhancement and Assurance in Higher Education, and the Dean's Annual Report on the work and operation of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek.

2.2. Describe how the higher education institution has defined and published its standards and regulations on the assessment of the learning outcomes (examination procedures) achieved within the study programmes it carries out, including verification methods related to quality assurance, impartiality, transparency, procedures in cases of appeals and other relevant areas.

The Ordinance on Studies and Studying at Josip Juraj Strossmayer University of Osijek regulates in more detail the rules of assessment of the achieved learning outcomes, i.e. examination procedures (written and oral exams, practical part of the exam, prerequisites, examination periods, a number of exam attempts, etc.), a grade appeal procedure, an exam retake procedure, content, format, and manner of examination record keeping, ensuring transparency in exams, the right to access exam results, and other related matters. The Ordinance on Studies and Studying at Josip Juraj Strossmayer University of Osijek is published on the website of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and is therefore available to the public, especially to current students and aspiring students.

Based on the Criteria for Monitoring and Assessing Students Studying under the Bologna Process of 20 November 2007, the Student Evaluation Criteria were created and published on the Faculty website. The latest version was adopted at the 244th session of the Faculty Council of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, which was held on 2 June 2020. Pursuant to that version, every teacher is obliged to establish student evaluation criteria for each course in the manner prescribed in the document. The document is available at the following link: https://www.ferit.unios.hr/2021/upisi-i-studiji/dokumenti-za-upise-i-studije#dokument-okviri-kriterija-ocjenjivanja-2020pdf.

The examination criteria for each individual course within study programmes are clearly stated and displayed on related course pages on the Merlin e-learning platform (https://moodle.srce.hr/) as well as on the Faculty website: https://www.ferit.unios.hr/2021/upisi-i-studiji/diplomski-sveucilisni-studij.

The learning outcomes for all courses of undergraduate and graduate university study programmes as well as the undergraduate professional study programme of the Faculty were adopted at the 175th regular session of the Faculty Council held on 10 March 2015, within the framework of the Decision on the Compliance of the Study Programmes with the Act on Scientific Activity and Higher Education. In addition to the learning outcomes, the passing thresholds and the share in the final grade are precisely defined for each activity. As stated in 2.20, one of the main reasons for the amendments to the study programme is the implementation of the project "Application of the Croatian Qualifications Framework for University Study Programmes in the Field of Electrical Engineering – HKO-ELE". Within the framework of the project, workshops on learning outcomes were held for teachers, and compulsory and optional sets of learning outcomes were defined for individual qualification standard proposals. The procedures and evaluation examples referring to each set of learning outcomes are specified for each set of learning outcomes in the proposed qualification standards. The aforementioned activities contribute to the verification of the achievement of the learning outcomes.

An important part of quality assurance is the University student survey, which is conducted pursuant to Josip Juraj Strossmayer University of Osijek guidelines. The survey is filled out by full-time students of all

years of study. The survey is usually conducted at the end of the academic year. Through survey questions, students evaluate courses, the criteria for assessing student knowledge and work, teacher availability and attitude towards students. The management of the Faculty analyses survey results and takes necessary actions as needed, while aggregated results are presented at the Faculty Council. The Commission for Quality Enhancement and Assurance in Higher Education prepares and sends individual results to every teacher, and in the case of frequent or major complaints by students, the President of the Commission, together with the Dean, talks to and helps certain teachers who need to introduce changes. The results of student surveys are used to verify the fulfilment of necessary conditions laid down by the Rector's Conference for the evaluation of teaching and professional activity in the process of appointing teachers to scientific-teaching and teaching titles.

In addition, the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek conducts a Faculty Survey on Learning Outcomes and ECTS Credits, by means of which student academic workload is evaluated, i.e., the number of working hours spent on mastering individual activities in the course, and thus passing the exam. It is also evaluated to what extent the teachers taught content provided for by the study programme and how much the individual forms of teaching contributed to the successful adoption of the learning outcomes. These data are compared with the data on the exam pass rate obtained for all courses in all study programmes.

Additional Faculty surveys are as follows:

- a survey of the postgraduate study programme, in which the students evaluate their supervisors, the Vice-Dean for Science and Postgraduate Studies, the Student Administration Office and the quality of information about the study programme, as well as the procedures and processes they encounter in this study programme,
- a survey for graduates i.e., alumni who evaluate their former teachers, the quality of course delivery and how much the Faculty has helped them in getting the desired employment and status within the company,
- a survey for employers who evaluate the quality of graduates employed in their companies and provide further feedback on the direction in which the Faculty should develop, particularly regarding the study programmes carried out by the Faculty, and
- a survey on professional services in which students evaluate their satisfaction with services provided by the Student Administration Office, the Vice-Dean for Education and Student Affairs Office, the Library, and the IT support service.

Furthermore, at its 234th regular session held on 5 November 2019, the Faculty Council of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek adopted the Quality Enhancement and Assurance Handbook for Higher Education, which describes the basic procedures and forms that are necessary to systematically monitor the compliance of activities with the "Standards and Guidelines for Quality Assurance in the European Higher Education Area". The Handbook describes, *inter alia*, the quality enhancement and assurance system, activities in the process of quality assurance and enhancement, as well as quality indicators defined as a quality enhancement measure which are an integral part of internal evaluation adopted by the Faculty Council at the end of the academic year, among which are:

- Number of candidates applying for the study programme/Admission quota;
- Number of students enrolled in the first year of study/Number of graduates per year;
- Total number of students/Number of repeater students;
- Total number of students enrolled in university study programmes/Number of teachers appointed to scientific-teaching titles;
- Total number of students enrolled in professional study programmes/Number of teachers appointed to teaching titles;

- Number of students enrolled in a higher year of study/Number of students enrolled in the first year of study;
- Number of students enrolled in the postgraduate study programme;
- Number of foreign students enrolled in the first year of the postgraduate study programme/Total number of students enrolled in the first year of the postgraduate study programme;
- Number of doctoral dissertations defended;
- Number of research papers published in journals indexed in the Web of Science database/Number of teachers appointed to scientific-teaching titles;
- Citation of papers indexed in the *Web of Science* database;
- Total impact factor of papers/Number of research papers published in journals indexed in the *Web of Science* database;
- Number of research papers in the five-year period published in journals that, according to their impact factor, belong to the top 25% of journals within the corresponding subject category (Q1)/Number of research papers published in journals indexed in the *Web of Science* database in the five-year period;
- Number of competitive research projects approved for funding/Number of competitive research project applications (Croatian Science Foundation, UKF, FP7, Horizon2020);
- Contracted funds for competitive research projects;
- Number of other research projects approved for funding/Number of applications for other research projects (IPA, PoC, contracts with partners from the industry, etc.);
- Contracted funds for other research projects;
- Number of researchers who spent at least two weeks at foreign institutions/Total number of teachers appointed to scientific titles, assistants, postdoctoral researchers and research assistants;
- Outgoing teacher mobility/Number of teachers appointed to teaching and scientific-teaching titles;
- Incoming teacher mobility/Number of teachers appointed to teaching and scientific-teaching titles.

2.3. How do you ensure student participation in all processes related to the quality assurance of the higher education institution?

Within the Faculty Council of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, there are student representatives elected by the Student Union. Student representatives must make up at least 15% of the members of the Faculty Council. During the decision-making in the Faculty Council, student representatives can exercise a suspensive veto on matters of particular interest to students, such as changes in the study system, quality assurance, proposing study programmes, implementation of syllabi and issues related to student standards..

The student representative is a member of the Ethics Committee, the Committee for Awarding Students, the Commission for Quality Enhancement and Assurance and the Disciplinary Board. The student representative is also appointed to the Working Group for Learning Outcomes and participates in the work of the aforementioned bodies, especially when it comes to revising old or creating new quality-related documents.

In addition to their representatives, students can directly participate in the processes related to quality assurance at the higher education institution, primarily by completing the University Student Survey and the Survey on Learning Outcomes and ECTS Credits, as well as the Survey on Professional Services.

Based on these surveys, in the case of unfavourable results, the Faculty management defines measures to increase quality in the respective cases. The results of the University student survey are also used for

the evaluation of teaching and professional activities in the appointment process to scientific-teaching and teaching positions required by the Rector's Conference.

2.4. How do you ensure participation of labour market representatives in the development of the higher education institution?

The management of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek has expressed its interest in strengthening the connection between the industry and the activities organised by the Faculty. Increasing collaboration with the surrounding economy is one of the goals outlined in the Draft Development Strategy of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek 2021–2025.

Therefore, scientific and professional conferences are organised, and interested experts are always invited to participate. Examples include international scientific conferences such as the *International Conference on Smart Systems and Technologies* (https://sst-conference.org/), the *International Conference on Organisation and Technology of Maintenance* (https://oto2021.panon.eu/), and the *Cyber Security Conference* (https://csc.ferit.hr/). Additionally, occasional presentations by the economy and other entities are organised, involving discussions with students and teachers (panel discussions and guest lectures).

The Faculty of Electrical Engineering, Computer Science and Information Technology Osijek makes efforts to establish a link between employers and students through the "Open Doors and Career Day" (DOVIK), which is organised every spring. Efforts are made to present high school and university students with:
• Everything the Faculty offers (primarily through demonstrations in laboratories),
• Everything that companies offer, i.e., where they can find employment after completing their studies, presented through 15-minute company presentations or interesting demonstrations of activities that companies engage in.

A portal for FERIT students and employers, called STUP (https://stup.ferit.hr/), has been established. STUP, which connects our students and employers, was launched on 1 May 2016. Through this portal, companies can directly inform students about opportunities for:

- Employment,
- Scholarships,
- Completion of their final papers/Master's theses in the company,
- Practical training,

as well as publish all other non-commercial content and activities of interest to our students.

Additionally, companies have access to data on students interested in collaboration, and the Faculty informs companies about academic and extracurricular activities they can engage in. The Faculty of Electrical Engineering, Computer Science and Information Technology Osijek also organises and hosts guest lectures held by companies, which employers find highly beneficial and willingly participate in. Hence, in January 2022, the statistics on STUP were as follows:

- 457 companies using the portal, of which
- 62 companies offered practical training,
- 254 practical training positions were available, and 191 students completed their practical training in 55 companies.

Companies can publish all other non-commercial content and activities that are of interest to our students. One of the most significant collaborations between the Faculty and companies is established through

students' final papers and Master's theses. Companies can propose topics for Master's theses and final papers or act as co-mentors on a topic defined by our Faculty mentors.

The connection between the Faculty and labour market representatives is also evident in the awarding of the best students on the occasion of the Faculty Day. For example, in 2021, our students were awarded by companies such as HOPS, ATO Inženjering, Institut RT-RK, Plava tvornica d.o.o., Cobe d.o.o., Infobip d.o.o., Siemens d.d., OG Consultancy Services d.o.o., FINA, TEO Belišće d.o.o., Hrvatska gospodarska komora (*Croatian Chamber of Economy*), Hrvatska komora inženjera elektrotehnike (*Croatian Chamber of Electrical Engineers*), Belmet 97 d.o.o., and Hrvatski telekom d.d.

Faculty teachers are actively engaging in other scientific and professional projects involving collaboration with the industry. As a result, collaboration agreements were signed with the following companies: Državni zavod za mjeriteljstvo (*State Office for Metrology*), Sokol d.o.o., Centar za poduzetništvo, BIOS, MONO, Osijek Danas, Span d.o.o., HEP d.d., Končar – Institut za elektrotehniku d.d (*Končar-Electrical Engineering Institute*), Adacta d.o.o., Končar – elektronika i informatika d.o.o (*Končar-Electronics and Informatics*), Siemens, Danieli-Systec d.o.o., VACON AT, Osijek Software City, RT-RK Novi Sad, Orqa d.o.o., and Huawei Technologies d.o.o.

Additionally, five representatives of the labour market (including the president of the FERIT Alumni Club) are members of the Commission for Quality Enhancement and Assurance in Higher Education, which periodically provides recommendations for study programmes in light of labour market trends.

In terms of collaboration with the industry, accredited laboratories for testing low-frequency and high-frequency electromagnetic fields play a significant role. The Electromagnetic Compatibility Laboratory and the Laboratory for High Frequency Measurements have successfully undergone reaccreditation this year and have carried out a certain number of professional tasks. The specificities of these laboratories are highlighted on the Faculty website under "Collaboration with the Industry" and in separate promotional flyers for each laboratory (https://www.ferit.unios.hr/2021/znanost-i-suradnja/suradnja-s-gospodarstvom).

2.5. How is the information system for collecting, managing, processing, and reporting on statistical data related to the organisation and implementation of study programmes, and those necessary for quality assurance, structured?

The Higher Education Institutions Information System (ISVU) enables, among other things:

- generation of ad-hoc reports on student performance, exam pass rates;
- review of entered data based on specific criteria (e.g., top 10% of students, average exam grades);
- drawing up reports (required periodically by the Ministry of Science and Education, the University, etc.).

ISVU is a solution for coordinated digitalisation of all higher education institutions in the Republic of Croatia. It is primarily an application for the digitalisation of student-related activities at a higher education institution, allowing the management of databases related to students, teachers, courses, curricula, enrolments, and exams. Additionally, the application supports standard activities of any higher education institution, such as student enrolments, exam registration, grade entry, issuance of certificates and documents, and it automatically generates summary reports.

Study programmes are also defined through MOZVAG (a module for higher education institutions of the Agency for Science and Higher Education). The MOZVAG system is a standalone web application that

facilitates the preparation and assessment of teaching staff and material conditions for the implementation of the study programmes.

In addition, the Faculty has a system called “Mrkve” in which teachers enter reports on conducted classes, which are automatically compared with the syllabus implementation plan. The “Mrkve” system is also linked to the schedule of classes and exams, which is digitally accessible on the Faculty website: https://www.ferit.unios.hr/2021/studenti/raspored-nastave-i-ispita#predodabir. This schedule includes information on the division of students into smaller groups for various forms of instruction, such as laboratory exercises, etc.

Furthermore, the Faculty utilises the “Mak” system, which facilitates the process of conducting final and Master’s exams (including theses) from assigning topics to the automated generation of final reports and forms, as well as grading of students. Through “Mak”, it is possible to monitor student progress through the final/Master’s exam process, document submission and retrieval, file submissions, as well as evaluation by mentors, the Commission for Master’s Exams, and the Committee for Master’s Theses and Final Papers. The system also contains a repository of necessary documents and forms, serves as an information hub for students and teachers, and more.

All teaching materials for individual courses can be found on the e-learning system called Merlin (https://moodle.srce.hr).This platform also serves for communication between teachers and students, where all news related to individual courses is published, about which students receive notifications by email.

Within the scope of the project “Application of the Croatian Qualifications Framework for University Study Programmes in the Field of Electrical Engineering - HKO-ELE”, the existing system for creating the implementation plan and monitoring the implementation of study programmes has been improved and adapted. The functionalities have been expanded with the aim of enhancing the monitoring of quality indicators at FERIT. The mentioned improvements and system upgrades enable the tracking of the following data:

- Data on FERIT teachers:
  - Total number of employees;
  - Total number of employees by academic title;
  - Detailed information by name and surname (name and surname, type of position, employment percentage, and salary coefficient).
- Pass rate data for all exam sessions:
  - For each study programme, each year of the programme, and each course in the programme:
  - Semester of implementation, number of students who took the exam, number of students who passed the exam, percentage, average grade, number of newly enrolled students, and total number of enrolled students.
- Data regarding academic performance (for every study programme and year of study, with the option to select the academic year):
  - Number of enrolled students;
  - Number of first-time students in the study year compared to the number of first-time students in the previous study year/Number of first-time students in the previous study year;
  - Number of repeaters/Total number of students enrolled in the same year of study in the previous academic year;
  - Average total number of earned ECTS credits per year of study (the number of students is given in parentheses);
  - Individual student data.

2.6. How are the standards and regulations of the higher education institution defined and published regarding a periodic review of study programmes that involve external experts?

External experts are involved in the process of re-accreditation of the University every five years. The procedure of re-accreditation at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek was conducted in May 2018. The Accreditation Council of the Agency appointed an expert panel that included external experts. The procedure of re-accreditation was carried out based on the prepared self-evaluation report, the Ordinance on the Content of Licence and Conditions for Issuing Licence for Performing Higher Education Activity, Carrying Out a Study Programme and Re-accreditation of Higher Education Institutions, as well as the Ordinance on Conditions for Issuing Licence for Scientific Activity, Conditions for Re-accreditation of Scientific Organisations and Content of Licence. The process was also based on the Criteria for the Assessment of Quality of Higher Education Institutions within Universities of the Agency for Science and Higher Education.

Based on the re-accreditation evaluation (June 2018) and improvement recommendations, a Commission for the Development of a Quality Improvement Action Plan was established at the Faculty. The initial version of the Action Plan, created by the aforementioned Commission, was thoroughly analysed at a Quality Commission meeting. The final Action Plan was adopted at the 229th regular session of the Faculty Council held on 11 June 2019.

2.7. How are the standards and regulations for safeguarding students' rights defined and published, especially with regard to informing students, receiving and resolving student complaints, and procedures for protecting students' rights? How are the individuals responsible for students' rights issues (such as the Vice-Dean for Education, student ombudsmen, the Office for Student Affairs, etc.) designated?

Standards and regulations for the protection of students' rights, particularly with regard to informing students, receiving and resolving student complaints, and procedures for protecting students' rights, are defined by the Ordinance on Studies and Studying at Josip Juraj Strossmayer University of Osijek.

A Student Union has been established at the Faculty. The Student Union is a student-elected representative body that protects the interests of students, participates in decision-making processes in the Faculty Council, and represents students in the higher education system. The Student Union has a Statute, adopted by the Faculty Council upon the proposal of the Student Union. The Statute of the Student Union determines the working methods, bodies, composition, election procedures and jurisdiction of each body of the Student Union. It also specifies how the Student Ombudsman is appointed, how student representatives are elected to the Faculty bodies, the responsibility of the bodies and members of the Student Union for not fulfilling the tasks entrusted to them related to the work of the Student Union, as well as other matters important for the functioning of the Student Union.

The Student Union elects student representatives to the Faculty Council. Student representatives must constitute 15% of the members of the Faculty Council. During decision-making in the Faculty Council, student representatives have the right of a suspensive veto on matters of particular interest to students such as modifications in the study system, study quality assurance, amendments to study programmes and the implementation of syllabi, and issues related to student standards. The Faculty Council re-examines the issue after the suspensive veto, at the earliest within 8 days. In the repeated decision-making process, the decision is made by a simple majority from the total number of voting members of the Faculty Council, with no suspensive veto power.

The Student Ombudsman is appointed by the Assembly of the Student Union upon the proposal of the President of the Student Union. The Student Ombudsman receives complaints from students related to

their rights, discusses them with the relevant bodies of the Faculty, advises students on how to exercise their rights, and may participate in disciplinary proceedings against students to protect their rights.

The Vice-Dean for Education and Student Affairs is appointed by the Faculty Council upon the proposal of the Dean.

The Disciplinary Board for students consists of a president and two members, one of whom is a student. The Faculty Council appoints and dismisses the president and one member, along with their deputies from the ranks of the teaching staff. Additionally, the Student Union appoints and dismisses one member and their deputy from the ranks of students.

Pursuant to Article 70 of the Ordinance on Studies and Studying at Josip Juraj Strossmayer University of Osijek available at https://www.ferit.unios.hr/2021/studenti/zahtjevi-potvrde-i-propisi#dokument-pravilnik-o-studijima-i-studiranju, a student who is not satisfied with the received grade can, within 48 hours after the oral exam/oral part of the exam, or after the announcement of the written exam results, submit a request for retaking the exam before the Examination Committee.

2.8. How are standards and regulations for continuing professional development of all higher education institution employees in their respective fields defined and published, and how are reports on their implementation submitted?

Standards and regulations for continuing professional development of all higher education institution employees in their respective fields are defined by the Ordinance on Promotion into Scientific Titles, Scientific-Teaching and Artistic-Teaching Titles, Teaching, Assistant and Professional Titles, and Corresponding Job Positions at Josip Juraj Strossmayer University of Osijek, adopted by the Senate of Josip Juraj Strossmayer University of Osijek and published on the websites of both the Faculty and the University.

The Expert Committee for Assessing the Rector's Conference Criteria is a standing expert body of the Faculty Council which assesses the compliance with the requirements prescribed by the Rector's Conference regarding teaching and professional activities in the process of appointing faculty members to scientific-teaching and teaching titles. Additionally, it prepares reports on the verification of the requirements for these appointments.

With the aim of ensuring the quality of pedagogical, psychological and methodological skills for teaching at a higher education level, the Faculty provides all teachers with the opportunity to attend pedagogical-psychological and didactic-methodological training when they are first appointed to a scientific-teaching position. In addition to pedagogical-psychological and didactic-methodological training, continuing education of teachers and associates of the Faculty is ensured through scientific and professional lectures periodically held at the Faculty, as well as through institutional support for visits to foreign scientific and research institutions, conferences, workshops, and other forms of scientific and professional development.

Once a year, education and training records are collected for all employees of the Faculty with the aim of monitoring and planning. Based on the data collected through the form (Appendix IV of the FERIT Quality Manual) that employees submit to the Commission for Quality Enhancement and Assurance in Higher Education, the Commission submits a report to the Dean of the Faculty. The education and training records are used for strategic planning of education and lifelong learning of the Faculty staff. Therefore, the Commission creates two documents each year, i.e. an Education and Training Plan for the next year and a Report on Education and Training for the previous calendar year.

2.9. How is the quality of work of all professional services at the higher education institution ensured, and how is a report on this submitted?

Through regular communication among employees and professional services, the quality of work provided by professional services is analysed and improved, and, if necessary, appropriate measures are taken.

An important aspect of informing all employees is certainly the Intranet system where all relevant decisions, minutes and documents are published, making it easier for employees to perform their assigned tasks more efficiently.

Moreover, a student survey is conducted to evaluate the performance of all professional services within the higher education institution (see 2.2).

3. GENERAL INFORMATION ABOUT THE STUDY PROGRAMME

3.1. Name of the study programme

Graduate university study programme in Electrical Engineering

3.2. Provider of the study programme

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

3.3. Type of the study programme

University study programme

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

2 - graduate university

3.5. Scientific or artistic area

Technical Sciences

3.6. Scientific or artistic field

Electrical Engineering

3.7. Scientific or artistic branch

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

3.8. Admission requirements

Admission to the study programme is based on a public call.

The following candidates are eligible to enrol in the graduate university study programme in Electrical Engineering:

- candidates holding a university bachelor's degree in Electrical Engineering and Information Technology (earned in one of the elective modules *Power Engineering* or *Communications and Informatics*) awarded by the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek,
- candidates holding a professional bachelor's degree, following completion of additional coursework at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek and

passing all exams included therein, which makes them eligible to enrol in the graduate university study programme in Electrical Engineering.

The following candidates are also eligible to enrol in the graduate university study programme in Electrical Engineering:

- candidates holding a university bachelor's degree in Electrical Engineering awarded by other higher education institutions,
- candidates holding a university bachelor's degree in related fields of technical and natural sciences; in this case, the Committee for Education and Student Affairs determines the differential exams.

3.9. Duration of the study programme

The graduate university study programme lasts for two years (four semesters) and the student must earn a minimum of 120 ECTS credits.

3.10. Academic/professional title awarded upon completion of the study programme

Upon completion of the graduate university study programme in Electrical Engineering, a student is awarded the academic title of **Master of Electrical Engineering** with the branch indicated (Power Engineering, Industrial Automation or Communications and Informatics).

3.11. If you are proposing a specialist graduate professional study programme, attach a document referring to the accredited professional study programme in the same scientific or artistic field.

A specialist graduate professional study programme is not being proposed.

3.12. If you are proposing a graduate university study programme, attach a document referring to the accredited undergraduate university study programme in the same scientific or artistic field.

REPUBLIKA HRVATSKA
MINISTARSTVO ZNANOSTI, OBRAZOVANJA I ŠPORTA

KLASA: UP/I - 602-04/05-16/411
URBROJ: 533-07-05-2

Zagreb, 9. lipnja 2005.

Ministar znanosti, obrazovanja i športa temeljem članka 51. stavka 2. Zakona o znanstvenoj djelatnosti i visokom obrazovanju („Narodne novine", broj 123/03, 105/04, 174/04) izdaje

DOPUSNICU

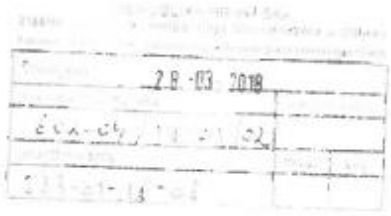
1. **Elektrotehničkom fakultetu Sveučilišta Josipa Jurja Strossmayera u Osijeku**, Osijek, Istarska 3, za izvođenje **preddiplomskoga sveučilišnog studija *Elektrotehnika***.
2. Studij traje tri godine.
3. Završetkom studija stječe se 180 ECTS bodova.
4. Studij se izvodi u sjedištu visokog učilišta.

Obrazloženje

Ministar znanosti, obrazovanja i športa temeljem članka 51. stavka 2. Zakona o znanstvenoj djelatnosti i visokom obrazovanju uputio je dana 1. travnja 2005. godine preddiplomski sveučilišni studijski program *Elektrotehnika* Elektrotehničkog fakulteta Sveučilišta Josipa Jurja Strossmayera u Osijeku, Osijek, Istarska 3, na mišljenje Nacionalnom vijeću za visoko obrazovanje.

Nacionalno vijeće za visoko obrazovanje donijelo je na 17. sjednici, održanoj dana 8. lipnja 2005. godine, mišljenje kojim preporučuje ministru izdavanje Dopusnice Elektrotehničkom fakultetu Sveučilišta Josipa Jurja Strossmayera u Osijeku, Osijek, Istarska 3, za izvođenje preddiplomskoga sveučilišnog studija *Elektrotehnika*. Studij traje tri godine i njegovim se završetkom stječe 180 ECTS bodova. Studij se izvodi u sjedištu visokog učilišta.

REPUBLIKA HRVATSKA
MINISTARSTVO ZNANOSTI I OBRAZOVANJA



KLASA: 602-04/17-13/00158
URBROJ: 533-20-17-0002

Zagreb, 22. ožujka 2018.

Na temelju odredbe članka 159. Zakona o općem upravnom postupku („Narodne novine", broj 47/09), članka 12. stavka 2. i 3. Pravilnika o sadržaju dopusnice te uvjetima za izdavanje dopusnice za obavljanje djelatnosti visokog obrazovanja, izvođenje studijskoga programa i reakreditaciju visokih učilišta („Narodne novine", broj 24/10) i dostavljene Odluke Senata Sveučilišta Josipa Jurja Strossmayera u Osijeku od 29. studenoga 2017. godine, sukladno odredbi članka 20. stavka 10. Zakona o osiguravanju kvalitete u znanosti i visokom obrazovanju („Narodne novine", broj 45/09), po ovlasti ministrice znanosti i obrazovanja, državna tajnica izdaje

POTVRDU

kojom se potvrđuje da je naziv odobrenoga studijskog programa preddiplomskoga sveučilišnog studija *Elektrotehnika* izmijenjen i dopunjen i novi naziv sada glasi: preddiplomski sveučilišni studij *Elektrotehnika i informacijska tehnologija* te je upisan u Upisnik studijskih programa.

Sukladno odredbi članka 20. stavka 10. Zakona o osiguravanju kvalitete u znanosti i visokom obrazovanju, a u skladu s člankom 12. stavkom 1. Pravilnika o sadržaju dopusnice te uvjetima za izdavanje dopusnice za obavljanje djelatnosti visokog obrazovanja, izvođenje studijskoga programa i reakreditaciju visokih učilišta (u daljnjem tekstu: Pravilnik), Senat Sveučilišta Josipa Jurja Strossmayera u Osijeku donio je na 3. sjednici, u akademskoj godini 2017./2018. održane dana 29. studenoga 2017. godine, Odluku o prihvaćanju izmjena i dopuna studijskog programa preddiplomskoga sveučilišnog studija *Elektrotehnika*, koje se odnose na izmjenu i dopunu naziva koji sada glasi: preddiplomski sveučilišni studij *Elektrotehnika i informacijska tehnologija* (KLASA: 602-04/17-03/43; URBROJ: 2158-60-01-17-10. od 29. studenoga 2017. godine) Fakulteta elektrotehnike, računarstva i informacijskih tehnologija Sveučilišta Josipa Jurja Strossmayera u Osijeku, Osijek, Ulica Kneza Trpimira 2b. Studij izvodi se u sjedištu visokog učilišta, u trajanju od dvije godine, čijim se završetkom stječe 120 ECTS bodova.

Sveučilišta Josipa Jurja Strossmayera u Osijeku dostavilo je ovome ministarstvu Odluku Senata Sveučilišta od 29. studenoga 2017. godine kojom se prihvaćaju izmjene i dopune studijskoga programa koji se odnose na promjenu naziva studijskog programa preddiplomskog sveučilišnog studija *Elektrotehnika* i novi naziv sada glasi: preddiplomski sveučilišni studij *Elektrotehnika i informacijska tehnologija*, a sukladno Uputi Ministarstva znanosti i obrazovanja o postupku izmjena i dopuna odobrenih studijskih programa javnih sveučilišta od 19. travnja 2012. godine (KLASA: 602-04/12-13/00004, URBROJ: 533-07-12-0008), izdanoj prema uputi Nacionalnog vijeća za visoko obrazovanje od 7. prosinca 2011.

Sveučilište Josipa Jurja Strossmayera u Osijeku dostavilo je ovome ministarstvu očitovanje (KLASA: 602-04/18-03/12, URBROJ: 2158-60-18-01-4) kojim se temeljem očitovanja Fakulteta elektrotehnike, računarstva i informacijskih tehnologija (KLASA: 602-04/18-01/03, URBROJ: 2158/80-01-18-22) potvrđuje da se izmjena odnosi i na studente trenutno upisane na preddiplomski

sveučilišni studij *Elektrotehnika* koji će završetkom studija steći akademski naziv sveučilišn/a prvostupnik/prvostupnica inženjer/inženjerka elektrotehnike i informacijske tehnologije. Po primitku ove potvrde Fakultet neće paralelno izvoditi dva studijska programa nego samo preddiplomski sveučilišni studij *Elektrotehnika i informacijska tehnologija*. Financijska sredstva iz državnoga proračuna korištena za izvođenje preddiplomskoga sveučilišnog studija *Elektrotehnika* prenamijenit će se za izvođenje preddiplomskog sveučilišnog studija *Elektrotehnika i informacijska tehnologija*.

Nakon primitka Odluke s propisanom dokumentacijom, Ministarstvo znanosti i obrazovanja izvršilo je dana 22. ožujka 2018. godine upis predložene izmjene i dopune naziva studijskog programa u Upisnik studijskih programa te je izdavanjem ove potvrde Fakultet elektrotehnike, računarstva i informacijskih tehnologija Osijek Sveučilišta u Josipa Jurja Strossmayera u Osijeku stekao pravo za izvođenje ovoga studija, sukladno odredbi članka 12. stavka 3. Pravilnika, odnosno za početak izvođenja predloženoga sveučilišnog studijskog programa.

DRŽAVNA TAJNICA

prof. dr. sc. Branka Ramljak

Dostaviti:
1. Fakultetu elektrotehnike, računarstva i informacijskih tehnologija Osijek Sveučilišta J. J. Strossmayera u Osijeku, n/r dekana prof. dr. sc. Drage Žagara, Kneza Trpimira 2b, Osijek
2. Sveučilištu J. J. Strossmayera u Osijeku, n/r rektora prof. dr. sc. Vlaše Guberca, Trg Svetog Trojstva 3, Osijek
3. Pismohrani.

Na znanje:
1. Agenciji za znanost i visoko obrazovanje, Donje Svetice 38/V, Osijek
2. Rektorskom zboru, Sveučilište u Zagrebu, Kralja Zvonimira 8, Zagreb

REPUBLIKA HRVATSKA
MINISTARSTVO ZNANOSTI I OBRAZOVANJA

REPUBLIKA HRVATSKA
Sveučilište Josipa Jurja Strossmayera u Osijeku

Primljeno	23. 05 2018	
Klasifikacijska oznaka		Org. jed.
602-04/18-01/02		
Urudžbeni broj	Privitak	Vrij.
533-01-18-14		

KLASA: 602-04/17-13/00158
URBROJ: 533-04-18-0007
Zagreb, 17. svibnja 2018.

Na temelju odredbe članka 159. stavak 6. Zakona o općem upravnom postupku („Narodne novine", broj 47/09), a u vezi sa člankom 20. stavak 10. Zakona o osiguravanju kvalitete u znanosti i visokom obrazovanju („Narodne novine", broj 45/09) i članka 12. stavka 2. i 3. Pravilnika o sadržaju dopusnice te uvjetima za izdavanje dopusnice za obavljanje djelatnosti visokog obrazovanja, izvođenje studijskog programa i reakreditaciju visokih učilišta („Narodne novine", broj 24/10), radi izmjene navoda u prethodnoj Potvrdi o upisu u Upisnik studijskih programa izmijenjenog i dopunjenog studijskog programa preddiplomskog sveučilišnog studija *Elektrotehnika i informacijska tehnologija* (KLASA: 602-04/17-13/00158, URBROJ: 533-20-17-0002, od 22. ožujka 2018. godine) Fakulteta elektrotehnike, računarstva i informacijskih tehnologija Sveučilišta Josipa Jurja Strossmayera u Osijeku, a na zahtjev Sveučilišta Josipa Jurja Strossmayera u Osijeku, po ovlasti ministrice znanosti i obrazovanja, državna tajnica izdaje

Izmjenu Potvrde

1. U Potvrdi izdanoj dana 22. ožujka 2018. godine (Klasa: 602-04/17-13/00158, URBROJ: 533-20-17-0002) Fakultetu elektrotehnike, računarstva i informacijskih tehnologija Sveučilišta Josipa Jurja Strossmayera u Osijeku za izmijenjeni i dopunjeni studijski program preddiplomskog sveučilišnog studija *Elektrotehnika* koji mijenja naziv u *Elektrotehnika i informacijska tehnologija* došlo je do pogreške u navođenju: „Studij se izvodi se u sjedištu visokog učilišta, u trajanju od dvije godine, čijim se završetkom stječe 120 ECTS bodova", koji nakon izvršene izmjene sada glasi: *„Studij se izvodi u sjedištu visokog učilišta, u trajanju od tri godine, čijim se završetkom stječe 180 ECTS bodova"*

2. Izmjene iz točke 1. i točke 2. ove Potvrde bit će upisane u izvornik Potvrde u obliku bilješke.

Izmjena ove Potvrde utemeljena je na činjenici da je Senat Sveučilišta Josipa Jurja Strossmayera u Osijeku na svojoj 3. sjednici održanoj 29. studenoga 2017. godine donio Odluku o prihvaćanju izmjena i dopuna studijskog programa preddiplomskog sveučilišnog studija *Elektrotehniku* na način da se mijenja naziv u preddiplomski sveučilišni studij *Elektrotehnika i informacijska tehnologija*. Iz predmetne Odluke Senata proizlazi da se izmijenjeni i dopunjeni studijski program preddiplomskoga sveučilišnog studija *Elektrotehnika i informacijska tehnologija* izvodi u sjedištu visokog učilišta, u trajanju od tri godine, čijim se završetkom stječe 180 ECTS bodova.

Izdavanjem ove Potvrde podaci o studijskom programu usklađeni su s prethodno unesenim podacima u Upisniku studijskih programa.

REPUBLIKA HRVATSKA MINISTARSTVO ZNANOSTI I OBRAZOVANJA ZAGREB

DRŽAVNA TAJNICA

prof. dr. sc. Branka Ramljak

Dostaviti:
1. Sveučilište Josipa Jurja Strossmayera u Osijeku, n/r rektora prof. dr. sc. Vlatke Čulara, Trg Sv. Trojstva 3, Osijek
2. Fakultet elektrotehnike računarstva i informacijskih tehnologija Sveučilišta Josipa Jurja Strossmayera u Osijeku, n/r dekana prof. dr. sc. Drage Žagara, Kneza Trpimira 2b, Osijek
3. Agenciji za znanost i visoko obrazovanje, Donje Svetice 38/V, Zagreb
4. Pismohrani.

REPUBLIKA HRVATSKA
MINISTARSTVO ZNANOSTI I OBRAZOVANJA

REPUBLIKA HRVATSKA
2158/80 Josipa Jurja Strossmayera u Osijeku
Fakultet elektrotehnike, računarstva i informacijskih tehnologija Osijek
Primljeno: 28-03-2018
Klasifikacijska oznaka: 602-04/18-01/02
Urudžbeni broj: 533-01-18-05
Prilozi | Vrij.

KLASA: 602-04/17-13/00158
URBROJ: 533-20-17-0002

Zagreb, 22. ožujka 2018.

Na temelju odredbe članka 159. Zakona o općem upravnom postupku („Narodne novine", broj 47/09), članka 12. stavka 2. i 3. Pravilnika o sadržaju dopusnice te uvjetima za izdavanje dopusnice za obavljanje djelatnosti visokog obrazovanja, izvođenje studijskoga programa i reakreditaciju visokih učilišta („Narodne novine", broj 24/10) i dostavljene Odluke Senata Sveučilišta Josipa Jurja Strossmayera u Osijeku od 29. studenoga 2017. godine, sukladno odredbi članka 20. stavka 10. Zakona o osiguravanju kvalitete u znanosti i visokom obrazovanju („Narodne novine", broj 45/09), po ovlasti ministrice znanosti i obrazovanja, državna tajnica izdaje

POTVRDU

kojom se potvrđuje da je naziv odobrenoga studijskog programa preddiplomskoga sveučilišnog studija *Elektrotehnika* izmijenjen i dopunjen i novi naziv sada glasi: preddiplomski sveučilišni studij *Elektrotehnika i informacijska tehnologija* te je upisan u Upisnik studijskih programa.

Sukladno odredbi članka 20. stavka 10. Zakona o osiguravanju kvalitete u znanosti i visokom obrazovanju, a u skladu s člankom 12. stavkom 1. Pravilnika o sadržaju dopusnice te uvjetima za izdavanje dopusnice za obavljanje djelatnosti visokog obrazovanja, izvođenje studijskoga programa i reakreditaciju visokih učilišta (u daljnjem tekstu: Pravilnik), Senat Sveučilišta Josipa Jurja Strossmayera u Osijeku donio je na 3. sjednici, u akademskoj godini 2017./2018. održane dana 29. studenoga 2017. godine, Odluku o prihvaćanju izmjena i dopuna studijskog programa preddiplomskoga sveučilišnog studija *Elektrotehnika*, koje se odnose na izmjenu i dopunu naziva koji sada glasi: preddiplomski sveučilišni studij *Elektrotehnika i informacijska tehnologija* (KLASA: 602-04/17-03/43; URBROJ: 2158-60-01-17-10, od 29. studenoga 2017. godine) Fakulteta elektrotehnike, računarstva i informacijskih tehnologija Sveučilišta Josipa Jurja Strossmayera u Osijeku, Osijek, Ulica Kneza Trpimira 2b. Studij izvodi se u sjedištu visokog učilišta, u trajanju od dvije godine, čijim se završetkom stječe 120 ECTS bodova.

Sveučilišta Josipa Jurja Strossmayera u Osijeku dostavilo je ovome ministarstvu Odluku Senata Sveučilišta od 29. studenoga 2017. godine kojom se prihvaćaju izmjene i dopune studijskoga programa koji se odnose na promjenu naziva studijskog programa preddiplomskog sveučilišnog studija *Elektrotehnika* i novi naziv sada glasi: preddiplomski sveučilišni studij *Elektrotehnika i informacijska tehnologija*, a sukladno Uputi Ministarstva znanosti i obrazovanja o postupku izmjena i dopuna odobrenih studijskih programa javnih sveučilišta od 19. travnja 2012. godine (KLASA: 602-04/12-13/00004, URBROJ: 533-07-12-0008), izdanoj prema uputi Nacionalnog vijeća za visoko obrazovanje od 7. prosinca 2011.

Sveučilište Josipa Jurja Strossmayera u Osijeku dostavilo je ovome ministarstvu očitovanje (KLASA: 602-04/18-03/12, URBROJ: 2158-60-18-01-4) kojim se temeljem očitovanja Fakulteta elektrotehnike, računarstva i informacijskih tehnologija (KLASA: 602-04/18-01/03, URBROJ: 2158/80-01-18-22) potvrđuje da se izmjena odnosi i na studente trenutno upisane na preddiplomski

sveučilišni studij *Elektrotehnika* koji će završetkom studija steći akademski naziv sveučilišn/a prvostupnik/prvostupnica inženjer/inženjerka elektrotehnike i informacijske tehnologije. Po primitku ove potvrde Fakultet neće paralelno izvoditi dva studijska programa nego samo preddiplomski sveučilišni studij *Elektrotehnika i informacijska tehnologija.* Financijska sredstva iz državnoga proračuna korištena za izvođenje preddiplomskoga sveučilišnog studija *Elektrotehnika* prenamijenit će se za izvođenje preddiplomskog sveučilišnog studija *Elektrotehnika i informacijska tehnologija.*

Nakon primitka Odluke s propisanom dokumentacijom, Ministarstvo znanosti i obrazovanja izvršilo je dana 22. ožujka 2018. godine upis predložene izmjene i dopune naziva studijskog programa u Upisnik studijskih programa te je izdavanjem ove potvrde Fakultet elektrotehnike, računarstva i informacijskih tehnologija Osijek Sveučilišta u Josipa Jurja Strossmayera u Osijeku stekao pravo za izvođenje ovoga studija, sukladno odredbi članka 12. stavka 3. Pravilnika, odnosno za početak izvođenja predloženoga sveučilišnog studijskog programa.

DRŽAVNA TAJNICA

prof. dr. sc. Branka Ramljak

Dostaviti:
1. Fakultetu elektrotehnike, računarstva i informacijskih tehnologija Osijek Sveučilišta J. J. Strossmayera u Osijeku, n/r dekana prof. dr. sc. Drage Žagara, Kneza Trpimira 2b, Osijek
2. Sveučilištu J. J. Strossmayera u Osijeku, n/r rektora prof. dr. sc. Vlade Guberca, Trg Svetog Trojstva 3, Osijek
3. Pismohrani.

Na znanje:
1. Agenciji za znanost i visoko obrazovanje, Donje Svetice 38/V, Osijek
2. Rektorskom zboru, Sveučilište u Zagrebu, Kralja Zvonimira 8, Zagreb

3.13. If you are proposing a postgraduate specialist study programme, attach a document referring to the accredited graduate university or integrated undergraduate and graduate study programme in the same scientific or artistic field.

A postgraduate specialist study programme is not being proposed.

3.14. If you are proposing a postgraduate university study programme, attach a document referring to the accredited graduate university or integrated undergraduate and graduate study programme in the same scientific or artistic field.

A postgraduate university study programme is not being proposed.

3.15. Analyse the compliance of the study programme with the strategic goals of the higher education institution.

The Development Strategy of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek for the period 2016-2020 was adopted at the 184th regular session of the Faculty Council held on 26 January 2016. The Strategy of Josip Juraj Strossmayer University of Osijek for the period 2021-2030 was adopted at the 2nd session of the Senate of Josip Juraj Strossmayer University of Osijek in the academic year 2021/2022, which was held on 24 November 2021. The Development Strategy of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek was drafted on the basis of the Strategy of Josip Juraj Strossmayer University of Osijek and it is now in the process of being adopted. The study programme is aligned with the Draft Development Strategy.

3.15.1 Mission

The mission of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek is as follows:

- educate experts who will create added value and contribute to the development of the Republic of Croatia with knowledge, skills and competencies acquired in the fields of electrical engineering, computer science and information technology;
- conduct classes based on knowledge gained in the implementation of competitive research projects and projects in cooperation with companies;
- develop the economy through innovation and technology transfer thus contributing to the development of society.

3.15.2 Vision

The vision of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek is to be an institution with developed educational and research capacities, ensuring competitiveness with European and global higher education institutions, scientific excellence, and international recognition in the fields of electrical engineering, computer science and information technology, as well as effective transfer of knowledge and new technologies to the economy.

3.16. List the competencies that a student acquires upon completing the proposed study programme and the jobs they are qualified for.

Depending on the branch and the elective module, upon completion of the graduate university study programme in Electrical Engineering at the Faculty of Electrical Engineering, Computer Science and

Information Technology Osijek, students become qualified to do the following jobs in the field of electrical engineering and other related scientific fields:

Branch: *Power Engineering*

Elective module: *Electric Power Systems*

- Evaluate the factors that improve the positive impacts of business operation;
- Develop a project plan using appropriate tools and techniques for project planning and management;
- Evaluate, at the level of theoretical considerations, additional aspects in the electric power system, namely those related to the electric power system components, the market, the quality and reliability of electricity supply as well as transient phenomena and stability of the electric power system;
- Apply the acquired skills related to market simulation and analysis, quality and reliability of electricity supply;
- Apply the acquired skills related to simulation and analysis of transient phenomena and stability of the electric power system;
- Evaluate, at the level of theoretical considerations, all aspects related to the generation, transmission, distribution, protection and management of the power system;
- Apply the acquired skills related to simulation and analysis in the planning, construction, operation and maintenance phase of electric power components, plants and systems;
- Design electrical installations and lighting;
- Based on analyses and calculations, design electric power components, plants and systems;
- Analyse the operating states of different types of electric machines and carry out diagnostic methods of testing electric machines;
- Identify engineering tasks, required knowledge and skills related to production technology, prescribed occupational safety measures and procedures as well as regulations and standards.

Elective module: *Sustainable Power Systems*

- Evaluate the factors that improve the positive impacts of business operation;
- Develop a project plan using appropriate tools and techniques for project planning and management;
- Evaluate, at the level of theoretical considerations, additional aspects related to energy efficiency, technologies, design and integration of distributed generation from renewable energy sources and smart grids;
- Apply the acquired skills related to simulation and analysis of energy efficiency in electrical systems;
- Apply the acquired skills related to simulation and analysis of electricity generation and the impact of distributed generation from renewable energy sources on the electric power system;
- Evaluate, at the level of theoretical considerations, all aspects related to the generation, transmission, distribution, protection and management of the power system;
- Apply the acquired skills related to simulation and analysis in the planning, construction, operation and maintenance phase of electric power components, plants and systems;
- Design electrical installations and lighting;
- Based on analyses and calculations, design electric power components, plants and systems;
- Analyse the operating states of different types of electric machines and carry out diagnostic methods of testing electric machines;
- Identify engineering tasks, required knowledge and skills related to production technology, prescribed occupational safety measures and procedures as well as regulations and standards.

Branch: *Industrial Automation*

- Evaluate the factors that improve the positive impacts of business operation;
- Develop a project plan using appropriate tools and techniques for project planning and management;
- Identify engineering tasks, required knowledge and skills related to production technology, prescribed protection measures and procedures;
- Design and implement systems for measuring process quantities;
- Design power supply systems and electrical installations in industrial plants;
- Design automated industrial systems based on knowledge of dynamic models of electric drives, industrial communication protocols and the fundamentals of mechatronics;
- Analyse and apply algorithms for identification of drive and process parameters and optimisation of automated drive controller parameters;
- Implement digitalisation and optimisation of the manufacturing process;
- Apply the principles of electromagnetic compatibility and energy efficiency measures in industrial systems;
- Analyse the operation of real-time simulation systems and simulation results;
- Analyse elements of automated electric drives and design digital process controllers based on knowledge of classical controller synthesis methods and artificial intelligence methods.

Branch: *Communications and Informatics*

Elective module: *Communication Technologies*

- Evaluate the factors that maximise the positive impacts of business operation;
- Develop a project plan using appropriate tools and techniques for project planning and management;
- Identify engineering tasks, required knowledge and skills related to production technology, prescribed occupational safety measures and procedures as well as regulations and standards;
- Design analogue and digital circuits using a given technology;
- Analyse and evaluate the operation of receivers and transmitters (optoelectronic, radio-relay and satellite);
- Analyse and determine analytically and/or numerically the field components for different configurations and the dynamics of the change in the charge state of radiating structures;
- Design the basic computer network parameters and integrate the network with the global network;
- Develop and verify a software solution for the microcontroller-based system;
- Analyse and evaluate modulation procedures for given communication systems;
- Analyse video coding procedures and develop still image and video processing algorithms;
- Calculate RF signal coverage of cellular mobile communication systems.

Elective module: *Network Technologies*

- Evaluate the factors that maximise the positive impacts of business operation;
- Develop a project plan using appropriate tools and techniques for project planning and management;
- Identify engineering tasks, required knowledge and skills related to production technology, prescribed occupational safety measures and procedures as well as regulations and standards;
- Create a programming code (application) and conduct structural and functional testing of the developed application;
- Apply the rules of optimal source coding;
- Analyse and calculate near and far fields for different configurations and the dynamics of the change in the charge state of radiating structures;
- Design the basic computer network parameters and integrate the network with the global network;

- Develop and verify a software solution for the target architecture;
- Implement mechanisms, methods and protocols of flow control, congestion control and security in the computer network;
- Analyse video coding procedures and develop still image and video processing algorithms;
- Calculate RF signal coverage of cellular mobile communication systems.

3.17. Describe the mechanism for ensuring vertical student mobility in the national and international higher education space. If it refers to the first level of professional or university study programmes, indicate which specialist graduate professional study programmes or graduate university study programmes could be pursued at the proposing institution and/or at another higher education institution in the Republic of Croatia.

Figure 1 shows a vertical scheme of the study programmes carried out at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek. Masters of Electrical Engineering who complete the graduate university study programme in Electrical Engineering are eligible to enrol in the postgraduate specialist study programmes or the postgraduate doctoral study programme at the Faculty (see Figure 1), but they can also apply for admission to other related faculties at other universities in Croatia and abroad, following the conditions of those institutions.

The implementation of the project “Application of the Croatian Qualifications Framework for University Study Programmes in the Field of Electrical Engineering - HKO-ELE” has ensured the harmonisation of study programmes in the field of electrical engineering with the proposed qualification standard, thereby facilitating easier vertical student mobility at the national level.

Outgoing and incoming student mobility in the international arena is ensured during studies through the Erasmus+ International Mobility Programme between the Faculty and about 70 foreign higher education institutions. Mobility also takes place through IAESTE and other mobility programmes.

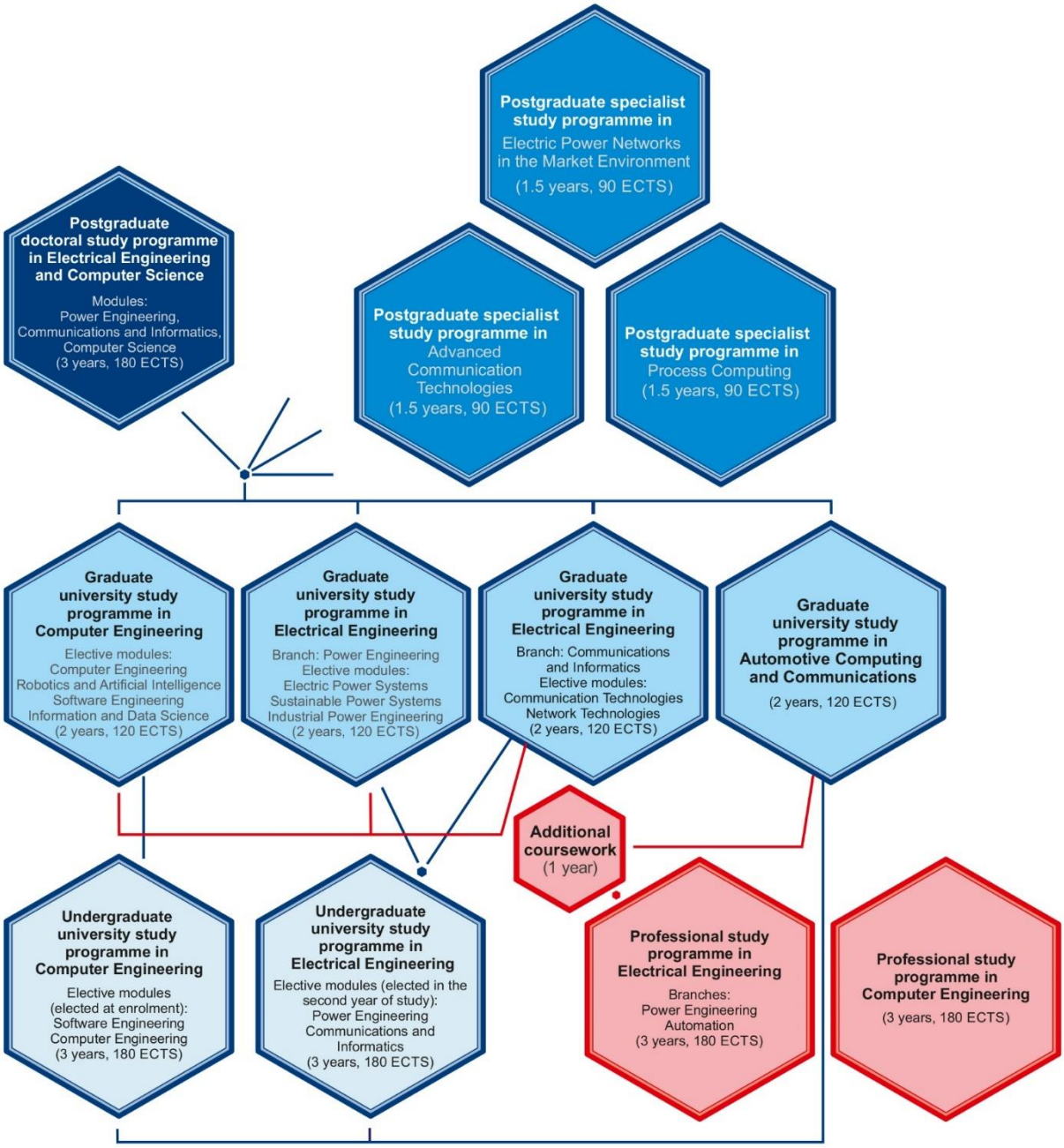


Figure 1. Vertical scheme of studying at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek

3.17.1 Courses in other study programmes that students can opt for and enrol in

Students have the option to choose elective courses offered every academic year at Josip Juraj Strossmayer University of Osijek. For example, in the academic year 2021/2022, a total of 49 courses were offered at 17 University constituent units. The list is available at the following link: http://www.unios.hr/wp-content/uploads/2021/07/Odluka-Kolegiji-2122-.pdf

3.17.2. List of courses which can be taught in a foreign language

A list of courses that can be taught in a foreign language can be found under 4.4. In total, there are 69 courses that can be taught in English.

3.17.3. Criteria and conditions for the transfer of ECTS credits

The Faculty organises and carries out the Erasmus+ International Mobility Programme. Within the framework of this programme, students are able to spend one part of their studies at a foreign higher education institution and/or undergo practical training, which significantly contributes to their independence, cultural enrichment, proficiency in foreign languages and ability to work in multicultural environments. 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+ International Mobility Programme. At the proposal of the Erasmus coordinator, the Committee for Education and Student Affairs lays down the criteria and conditions for ECTS credit 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 the profession.

The contemporary study programme in electrical engineering is based on the overall rapid development of both natural sciences and technology. This is particularly evident in the development of the electrical, electronic, and ICT industries.

The market is undoubtedly a driver of development and research in this area and it will continue to be reliable support for further investments in science and research in the field of electrical engineering. From the above, there arises the need for constant monitoring of the latest scientific knowledge, through research and development at the Faculty, primarily within the framework of research projects under the auspices of the Ministry of Science, Education and Sports, through projects of the European Union and certainly through cooperation and projects with the economy. Continuous and excellent scientific work at the Faculty will ensure high quality of outgoing experts in electrical engineering.

It was stated earlier that the proposed amendments to the graduate university study programme in Electrical Engineering are largely based on the implementation of the project "Application of the Croatian Qualifications Framework for University Study Programmes in the Field of Electrical Engineering - HKO-ELE". When developing the occupational standard proposal, which is in line with the Methodology for the Development of Occupational Standards, relevant employers/labour market representatives in the fields of electrical engineering, information and communication technology and industrial automation in the Republic of Croatia were surveyed about the competencies that students need to acquire upon completion of their studies. In this way, it is ensured that the proposed study programme is connected with fundamental and contemporary skills and profession.

The graduate university study programme in Electrical Engineering is designed to educate students through the following three branches: Power Engineering, Industrial Automation and Communications and Informatics. Students in all three branches acquire competencies in project management and are obliged to undergo practical training.

Branch: Power Engineering

The proposed study programme, branch Power Engineering, follows the latest trends in power engineering, while maintaining the fundamental skills and competencies in relation to analysis and design, starting from conventional production plants, components and configurations of transmission and

distribution networks, electric power system protection and control, but introducing as mandatory production plants using renewable energy sources, economics and the electricity market, application of information and communication technology systems for the purpose of developing smart power grids and design of modern electrical installations and lighting. Depending on the elective module students opt for, additional contemporary topics are covered, e.g. electric power quality, transient phenomena, stability and reliability of the electric power system, switchgear and high voltage technology in the elective module Electric Power Systems, and energy efficiency with an emphasis on electricity, power electronics, energy storage, electric vehicles, and the integration of distributed generation from renewable energy sources into the electric power system in the elective module Sustainable Power Systems. In addition, students are also offered a number of additional elective courses that deepen basic knowledge in electric drives and measurements, power system planning and operation, and protection coordination of active networks, and develop engineering skills such as the application of computer methods, software and simulation tools in power engineering, power plant design, grounding systems and standby power supply systems, energy audits, public lighting and renewable heat applications.

Branch: Industrial Automation

The proposed study programme, branch Industrial Automation, is based on a systematic approach to solving engineering and research tasks and provides specialisation in the areas where automation and production system management are of utmost importance. By acquiring knowledge in the fields of industrial plant design, the use of industrial communication protocols, process parameter identification and dynamic model development, students will be able to gain competencies necessary for working in advanced production, mechatronic and transportation systems in line with digitalisation trends. Depending on student selection, they can focus on the areas of industrial inspection and design systems, from installation, selection of proper measuring transducers, application of power electronics, the basics of robotics, real-time computer simulations, and the concept of application of x-IL systems and digital doubles, to the basic knowledge of power supply systems and electric vehicle propulsion, energy storage, as well as propulsion of robotic manipulators as a wider environment of industrial systems..

Branch: Communications and Informatics

The proposed study programme, branch Communications and Informatics, provides the possibility of acquiring basic and specialist knowledge in the field of communication and network technologies, information systems and related computer skills and knowledge. This knowledge and skills enable work on research, development, improvement and maintenance of existing information and communication systems, as well as creation of new data transmission, storage and processing systems. Depending on the selected elective module, students acquire additional competencies in the field of microelectronics, radiocommunications and optoelectronic communications, application of microcontrollers, transmitters and receivers, i.e. digital image and video processing, machine learning, computer systems security, the Internet of Things, communication protocols, codes and coding, and embedded systems. In today's world, information has become the most important product, and information transfer is the basis on which the development of that world is based. Therefore, the knowledge and skills in the field of communication and information systems that can be developed and improved has a great and direct impact on modern society and the development of technology.

3.19. Explain how the study programme is connected to the demands of the local community (economy, entrepreneurship, civil society, etc.).

The connection of the study programme to the needs of the local community is partly described in 2.4, which discusses the involvement of labour market representatives in the development of the higher education institution.

The study programme is expected to meet the requirements of the local community for new jobs, particularly in terms of reducing unemployment (see 3.20).

Namely, the analysis of data from the labour market in Croatia shows that professionals who complete graduate study programmes in electrical engineering are employed much faster even in high unemployment conditions. Communications and informatics, industrial automation, electrical engineering and power engineering are important foundations of development of every society, and the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek is the only institution in Eastern Croatia that trains highly educated professionals in these fields, which forms the basis not only for future successful education of professionals in electrical engineering, but also for the retention and recruitment of highly educated staff as well as economic growth and development, both of the region and of Croatia as a whole.

The graduate university study programme in Electrical Engineering, together with the undergraduate university study programme in Electrical Engineering and Information Technology, forms a logically rounded whole of education of experts in this field. Depending on the branch they opt for, Masters of Electrical Engineering will, each with their additional competences, be able to face complex problems in both research and development and the application of new technologies in power engineering, industry and the information and communication sector.

Electrical engineering is present in all segments of human life, and without it, it is impossible to imagine the overall social and economic development of modern society, including the development of Croatia. It is undeniable that electrical engineering will continue to be the driver of societal development, which will require highly qualified experts who can meet the challenges of the new era. With additional contemporary skills and competencies, highly educated experts in electrical engineering, who are educated at the Faculty of Electrical Engineering, Computer Engineering and Information Technology Osijek, have found and will undoubtedly continue to find their place in the labour market.

3.20. Attach an analysis of the employability of students after completing the study programme, including the opinion of at least three organisations related to the labour market (e.g. professional associations, employers and their associations, trade unions, public services) on the alignment of the intended learning outcomes acquired upon completion of the studies with the needs of the labour market.

According to the official data from the Croatian Employment Service at the beginning of January 2022, it is noticeable that the unemployment rate has been very low in recent years. However, it should be noted that almost all students who complete the undergraduate university study programme in Electrical Engineering and Information Technology enrol in and complete the graduate university study programme before entering the workforce.

Tables for the undergraduate university study programme in Electrical Engineering and Information Technology:

The number of newly enrolled students in the graduate university study programme in Electrical Engineering					
2017	**2018**	**2019**	**2020**	**2021**	**Total**

135	**130**	**140**	**142**	**137**	**684**

Newly registered with the Croatian Employment Service aged up to 39 years						**Newly registered with the Croatian Employment Service aged up to 39 years and employed within 6 months**					
2017	**2018**	**2019**	**2020**	**2021**	**Total**	**2017**	**2018**	**2019**	**2020**	**2021**	**Total**
13	**8**	**9**	**12**	**6**	**48**	**6**	**8**	**3**	**7**	**5**	**29**

Tables for the graduate university study programme in Electrical Engineering:

The number of newly enrolled students in the graduate university study programme in Electrical Engineering					
2017	**2018**	**2019**	**2020**	**2021**	**Total**
55	**60**	**72**	**73**	**79**	**339**

Newly registered with the Croatian Employment Service aged up to 39 years						**Newly registered with the Croatian Employment Service aged up to 39 years and employed within 6 months**					
2017	**2018**	**2019**	**2020**	**2021**	**Total**	**2017**	**2018**	**2019**	**2020**	**2021**	**Total**
63	**50**	**37**	**33**	**30**	**213**	**50**	**42**	**28**	**31**	**26**	**177**

It should be pointed out that the actual unemployment rate may be slightly higher than depicted above. Namely, when registering with the Croatian Employment Service, entering the name of the educational institution and the year of graduation is not mandatory.

Positive opinions from at least three organisations related to the labour market are attached in Appendix 7.3.

3.21. Compare the proposed professional/university study programme with foreign accredited study programmes conducted at reputable higher education institutions, especially in the European Union.

The Technical University of Kaiserslautern has a graduate university study programme in Electrical Engineering and Information Technology which covers the following fields:

- Power Engineering,
- Communication Technology,
- Automation Engineering.

Courses that are similar to those offered in the branches Power Engineering and Industrial Automation are as follows:

- Digital Signal Processing,
- Modelling and Identification,
- Theoretical Electrical Engineering III,
- Synthesis and Optimisation of Microelectronic Systems I,
- Electromagnetic Compatibility,
- Electrical Measurement Technique II,
- Power System Planning and Operation I,
- Power Generation I: Thermal Power Plants,
- Power Generation II: Renewable Generation and Storage.

Courses that are similar to those offered in the branch Communications and Informatics are as follows:

- Digital Signal Processing,
- Introduction to Information and Coding Theory,
- Synthesis and Optimisation of Microelectronic Systems I,
- Wireless Communication,
- Digital Signal Transmission,
- Wireless and Multimedia Systems,
- Communications Engineering,
- Electrical Measurement Technique II,
- Logic Control.

The Technical University of Wien has a graduate university study programme in Electrical Engineering and Information Technology which covers the following fields:

- Embedded Computer Systems,
- Power Engineering and Automation,
- Telecommunications,
- Microelectronics and Photonics.

Courses that are similar to those offered in the branches Power Engineering and Industrial Automation are as follows:

- Electrical Drives,
- Automation and Control Systems,
- Power Electronics,
- Renewable Power Systems,
- Energy Economics,
- Power Transmission / Distribution and High Voltage Technology,
- Smart Power Grids,
- Signal Processing 1,
- Signal Processing 2,
- Power Electronics and EMC, Advanced Studies,
- EMC-Optimised Circuit Design,
- Circuit Design,
- Electrochemical Energy Conversion and Energy Storage.

Courses that are similar to those offered in the branch Communications and Informatics are as follows:

- Signal Processing 1,
- Signal Processing 2,
- Communication Networks 1,
- Digital Communications 2,
- RF Techniques,
- Digital Communications 2,
- Digital Integrated Circuits,
- Wireless Communications 1,
- Machine Learning Algorithms,
- Network Security - Advanced Topics,
- Information Theory for Communications Engineers,
- Mobile Digital Communications.

The Technical University of Bremen has a graduate university study programme in Electrical Engineering and Information Technology which covers the following fields:

- Automation,

- Renewable Energy Sources,
- Communication and Information Technology,
- Sensors and Electronics,
- Smart Electronic Systems.

Courses that are similar to those offered in the branches Power Engineering and Industrial Automation are as follows:

- Automation of Technical Processes,
- Electric Drive Technology,
- Regulation Theory 1,
- Process Automation in Power Grids,
- Electrical Power Plants,
- Dynamics in Transmission Networks.

Courses that are similar to those offered in the branch Communications and Informatics are as follows:

- Advanced Digital Signal Processing,
- Antennas and Propagation,
- Communication Networks,
- Network Simulation,
- Wireless Communications,
- Sensors and Measurement Systems,
- Circuits and Architectures for Mobile Communication Systems,
- Digital Technology.

Based on the comparison of the proposed graduate university study programme in Electrical Engineering with the aforementioned study programmes, it can be concluded that there is a high level of alignment between the proposed study programme and those reviewed ones, which ensures the possibility of exchange and flow of students and teachers between Croatian and European universities.

3.22. Describe prior experience of the institution proposing the study programme in carrying out the same or similar professional/university study programmes.

The graduate university study programme in Electrical Engineering and Information Technology has been carried out since the academic year 2005/2006.

In less than forty-two years since the Faculty was established, over 6,500 students have earned their degrees:

- pre-Bologna professional study programme in Electrical Engineering: 1,065
- pre-Bologna university study programme in Electrical Engineering: 950
- undergraduate university study programme in Electrical Engineering and Information Technology: 856
- undergraduate university study programme in Computer Engineering: 779
- undergraduate professional study programme in Electrical Engineering: 510
- undergraduate professional study programme in Informatics and Computer Engineering: 502
- graduate university study programme in Electrical Engineering: 967
- graduate university study programme in Computer Engineering: 824
- graduate university study programme in Automotive Computing and Communications: 35
- postgraduate doctoral study programme in Electrical Engineering: 83

The amendments to the study programme were proposed based on the implementation of the project "Application of the Croatian Qualifications Framework for University Study Programmes in the Field of Electrical Engineering - HKO-ELE" (https://hko-ele.ferit.hr/), which aimed to develop occupational standards and qualification standards, and to enhance and modernise existing university study programmes in the field of electrical engineering, including information and communication technology. Within the framework of the project, a survey of employers was carried out to align the study programmes with labour market needs.

3.23. If there are any, list the partners outside the higher education system (economy, public sector, etc.) who would participate in the implementation of the proposed study programme.

The proposed graduate university study programme in Electrical Engineering of the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek is based on the results of the project "Application of the Croatian Qualifications Framework for University Study Programmes in the Field of Electrical Engineering - HKO-ELE" and better integration with the economy and overall technological development. External associates will participate in the teaching process, practical training and Master's theses as partners whose activities are in the fields of electrical engineering and information technology. This collaboration has already been established through the STUP portal (for more details, see 2.4).

3.24. Write about how your higher education institution develops international cooperation.

The Faculty of Electrical Engineering, Computer Science and Information Technology Osijek has been cooperating with faculties, universities and research institutions in the country and abroad for a long time. This cooperation takes place through outgoing and incoming student, teaching and non-teaching staff mobility as well as research, teaching and professional activities. This primarily involves the exchange and hosting of teachers, scientific training of researchers, conducting research for doctoral dissertations, graduate theses and final papers, student internships, attending language courses, project research, and other activities. Additionally, there exists direct scientific, teaching and professional cooperation with colleagues abroad.

Since 1985, the Faculty, together with the Hochschule Bremen, University of Applied Science, has been a co-initiator of the conference *Science in Practice*, which is held alternately at the aforementioned institutions and at the Fachhochschule Würzburg - Schweinfurt, University of Applied Science, Pecs University, Polack Mihally College of Engineering, Pecs, Obuda University, Kando Kalman Faculty of Electrical Engineering, Budapest, and Subotica Technical College of Vocational Studies. In October 2014, the Faculty hosted the 32nd International Conference *Science in Practice*. There were about 60 participants and 40 papers were presented at that conference. Furthermore, the Faculty was a co-organiser of the international European Conference on Software Architecture (ECSA 2015), which took place in September 2015.

The Faculty is the organiser or co-organiser of several international and national conferences. It co-organised the 39th International Conference on Telecommunications and Signal Processing (TSP), which was held from 27 to 29 June 2016 in Vienna. Together with the Center of Excellence for Computer Vision (FER Zagreb), the Faculty co-organised the Fifth Croatian Computer Vision Workshop, which was held on 11 October 2016 in Osijek. It co-organised the 40th International Conference on Telecommunications and Signal Processing (TSP), which was held from 5 to 7 July 2016 in Athens.

In order to improve international cooperation and enhance the international visibility of research, the Faculty initiated the International Conference on Smart Systems and Technologies (SST). The first such conference was held from 12 to 14 October 2016 in Osijek, under the auspices of IEEE Region 8, the

IEEE Croatia Section, the Croatian branch of CIGRE, and in the period from 2016 to 2021, four more SST conferences were held.

The Faculty of Electrical Engineering, Computer Science and Information Technology Osijek is also the organiser of the international scientific and professional conference Organisation and Technology of Maintenance - OTO. The objective of this conference is to raise the level of knowledge about maintenance, taking into account the continuous technological progress in all spheres of economy, infrastructure and public services. The idea and realisation of the first OTO conferences began over 27 years ago at the then Faculty of Electrical Engineering in Osijek. Since then, we have witnessed the continuous growth of the Faculty as well as the profiling of the OTO conference, which has grown into a regional interdisciplinary scientific and professional conference. In order to maintain continuity after the cessation of activity of the Osijek Maintenance Society, the Faculty took over the organisation of this traditional conference, which has resulted in a large number of authors from the higher education system, a group that dominated the conference in the last several years. The OTO scientific and professional conference represents an opportunity for the direct exchange of experiences among experts from all fields of maintenance with the aim of researching and analysing new methods and procedures.

Furthermore, the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek hosted and organised the 26th International Conference on Systems, Signals and Image Processing IWSSIP 2019. The conference was held from 5 to 7 June 2019, and the goal was to provide researchers and experts with a platform for the development and dissemination in the field of theoretical, experimental and applied signal and image processing. The scientific programme of the IWSSIP 2019 conference was divided into ten sections dealing with contemporary topics in the field of image and video processing, signal processing in electronics, processing and analysis of biomedical signals and images, image and video processing for autonomous driving, machine learning and signal processing in communication networks and systems. The programme included a preliminary lecture, five invited lectures by world-renowned scientists, an industrial section, and 46 research papers by about 150 authors from 25 countries and five continents.

Since 2015, the Faculty has been a partner institution in the Centre of Research Excellence for Data Science and Cooperative Systems, the first centre of excellence in the field of technical sciences in Croatia, whose purpose is to advance Croatian science and strengthen its inclusion in the European Research Area. The Centre consists of two research units – the Data Science Research Unit and the Advanced Cooperative Systems Research Unit (ACROSS). The Data Science Research Unit brings together 49 scientists from nine collaborating institutions, while the ACROSS research unit brings together 32 leading experts from 7 collaborating Croatian institutions.

Important international cooperation was achieved by involving the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek in the organisation of HiPEAC - European Network on High Performance and Embedded Architecture and Compilation in 2015. HiPEAC is an organisation of European researchers in the field of embedded and high-performance computers whose aim is to encourage cooperation between universities and industry, and computer system designers and development tool manufacturers. This cooperation resulted in the participation of the Faculty in the FP7 TETRACOM technology transfer project. The TETRACOM project connected 34 European universities and institutes with more than 50 sub-projects and 95 researchers.

The Faculty of Electrical Engineering, Computer Science and Information Technology Osijek has significant international cooperation with more than 80 reputable foreign research institutions. In the last five years, many projects have been initiated, applied for or are in the application process within the

framework of Danube Start, Erasmus Mundus Euroweb+, Erasmus+ KA 2, Interreg, COST and H2020 programmes.

Currently, the Faculty cooperates with the following foreign universities: Austria (Karl-Franzens-Universität Graz, Technische Universität Wien), Belgium (KU Leuven), Bosnia and Herzegovina (University of Mostar, University of Tuzla, ETF Sarajevo of the University of Sarajevo), Lithuania (Vilnius University), Hungary (Pecsi Tudományegyetem - University of Pecs, Budapesti Műszaki Főiskola - Budapest Tech), the Netherlands (Eindhoven University of Technology), Germany (Hochschule Albstadt-Sigmaringen, Albstadt, Hochschule Bremen - University of Applied Sciences, Fachbereich Elektrotechnik, Informatik, Bremen, Internationale Begegnungs- und Forschungszentrum für Informatik – Dagstuhl, Fachhochshule Giessen-Friedberg, University of Applied Sciences, Giessen, Universität des Saarlandes, Saarbrücken, Hochschule für angewandte Wissenschaften (FHWS), Wűrzburg, Schweinfurt), Poland (Lodz University of Technology, Bydgoszcz University of Science and Technology), Portugal (Instituto Politécnico do Porto), Romania (Stefan cel Mare University of Suceava, Politehnica University of Bucharest), the USA (West Virginia University, Morgantown, WV), Serbia (University of Novi Sad, Faculty of Technical Sciences, Subotica Tech – College of Applied Sciences, Subotica, University of Niš), Slovakia (Slovak University of Technology, Faculty of Electrical Engineering and Information Technology, Bratislava, Slovak University of Agriculture in Nitra, University of Žilina - Faculty of Management Science and Informatics), Slovenia (University of Maribor, FERI Maribor, Krško, University of Ljubljana, Jožef Štefan Institute, University of Primorska, Koper), Spain (Universidad Politécnica de Cataluña (UPC-Barcelona Tech), L'Escola Universitària d'Enginyeria), Sweden (Mälardalen Hogskola, Mälardalen University, Department of Computer Science and Electronics), Turkey (Süleyman Demirel University, Isparta), Great Britain (University of Glasgow - CRADALL), India (Indian Institute of Technology Indore, Woxsen University), Italy (University of L'Aquila), France (Telecom Paris Tech), and Ghana (University of Mines and Technology (UMat)).

The Faculty and the University have signed Erasmus+ exchange mobility agreements with the majority of the aforementioned European institutions, but they have also developed partnerships in research and professional projects.

Two teachers from Bosnia and Herzegovina (University of Mostar), two teachers from Slovenia (University of Maribor) and two teachers from Serbia (University of Novi Sad) participate in the teaching process at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, and the FERIT teachers also participate in the teaching process at those universities.

At the end of October 2018, the Joint PhD Cooperation Agreement was signed between Josip Juraj Strossmayer University of Osijek, i.e. the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, and the University of Ghent in Belgium. The doctoral dissertation, supervised by Irena Galić, PhD, Full Professor (FERIT), Aleksandra Pižurica, PhD, Full Professor (University of Ghent) and Danilo Babin, PhD, Associate Professor (University of Ghent), was written by Hrvoje Leventić, an assistant at FERIT, and defended on 5 February 2019.

In 2021, the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek signed a cooperation agreement with the European University Brčko District and the European University "Kallos" Tuzla, which defines and regulates cooperation for the purpose of developing educational, research and other forms of international cooperation in the field of higher education and science.

The Faculty has fruitful cooperation with the Faculty of Mechanical Engineering and Computing in Mostar at the levels of undergraduate, graduate and especially postgraduate doctoral study programmes.

Incoming and outgoing mobility of students, teaching and non-teaching staff is a significant activity within the framework of international cooperation. Mobility is realised on the basis of inter-university/inter-institutional agreements, and contributes to increasing visibility, international cooperation and internationalisation of the Faculty. FERIT has signed Erasmus+ bilateral agreements with 75 partner institutions from 23 countries and multilateral cooperation agreements with 6 higher education institutions from the USA, Germany, Hungary and Serbia.

In addition to the Erasmus+ programme, students do their practical training abroad, which is organised by the student association IAESTE. Students and employees are also included in the CEEPUS programme.

As of 11 January 2019, the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek has been a member of the CEEPUS network CIII-HR-1302-02-1920 - Research and Education of Environmental Risks. The main CEEPUS network coordinator is the Faculty of Civil Engineering and Architecture Osijek, and the network gathers 19 institutions from 11 countries. The goal of the network is to educate and train students to apply methods and state-of-the-art knowledge of natural hazards and risk assessment by integrating research and practical application to real building structures – by special risk analysis and decision-making. Other current topics in the network are engineering design methodology, construction analysis, protection against harmful vibrations in constructions, computer-supported technologies in construction mechanics and application in engineering and education, renewable energy sources, energy efficiency, application of software packages and techniques in the aforementioned areas, etc.

In 2014, the Faculty and Josip Juraj Strossmayer University of Osijek were included in the Erasmus Mundus mobility programme EUROWEB+ (European Research and Educational Collaboration with Western Balkans) with 18 other universities. Mobility between the EU and the countries of the so-called Western Balkans started in 2015. The Faculty also participates in several cross-border cooperation programmes, Erasmus+ projects, COST activities and other projects financed by the EU.

Systematic support in the processes of application and implementation of mobility for students, teaching and non-teaching staff is provided by the International and Inter-University Cooperation Office of the University of Osijek, and the Office for International Cooperation, Scientific and Professional Projects, the Erasmus coordinator and the Vice-Dean for International Cooperation at FERIT. In order to increase mobility, available funding programmes for visits to foreign higher education institutions, teaching, research and professional development as well as international networking opportunities are continuously presented.

Through the Erasmus+ mobility scheme, FERIT offers foreign students the opportunity to study at the English-taught postgraduate university study programme and take 26 courses at undergraduate and graduate study programmes. One of the Faculty's strategic goals was to initiate a study programme in a foreign language, which was reached in cooperation with the Faculty of Agriculture through the project "Development and establishment of a joint study-ICT in agricultural sciences" submitted to the public call "Internationalisation of higher education". An English-taught joint graduate university study programme in Digital Agriculture was launched in the academic year 2021/2022. The graduate university study programme in Automotive Computing and Communications has been conducted in English since the academic year 2019/2020.

Staff mobility refers to the stay of FERIT employees at a foreign host institution for the purpose of teaching, professional development (job shadowing, i.e. monitoring the work of colleagues, conferences, seminars, workshops and courses), cooperation arrangement, and participation in international projects and

conferences. In the period from 1 October 2013 to 30 September 2021, 76 teaching staff mobilities and 24 non-teaching staff mobilities were realised in 53 foreign institutions in 16 countries, whose purposes were either teaching and/or professional development. In addition to outgoing staff mobility, incoming staff mobility is also extremely important, and it includes the stay of foreign teaching and administrative staff at FERIT. In the aforementioned period, 84 foreign scientists and administrative staff members from 12 countries stayed at FERIT. An increase in incoming mobility in the academic year 2018/2019 was primarily a consequence of cooperation and mobility of consortium members within the Erasmus+ E-ProfEng project. In the period from 1 October 2013 to 30 September 2021, a total of 107 FERIT students stayed abroad for the purpose of studying and practical training, while a total of 78 students stayed at FERIT in the same period. All outgoing and incoming teaching/non-teaching staff mobilities lasted up to three months, while all student Erasmus+ mobilities (both incoming and outgoing) lasted for more than three months.

3.25. If the study programme is in the fields of regulated professions, elaborate on how you determined compliance with the minimum training requirements prescribed by Directive 2005/36/EC of the European Parliament and of the Council of 7 September 2005 on the recognition of professional qualifications and the Act on Regulated Professions and the Recognition of Foreign Professional Qualifications.

The study programme is not in the fields of regulated professions.

4. DESCRIPTION OF THE STUDY PROGRAMME

4.1. Attach a list of compulsory and elective courses with the number of contact hours and the number of 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 programme structure, pace and requirements for enrolment in the next semester or trimester as well as the requirements for each course or a group of courses.

The semester-based graduate university study programme in Electrical Engineering consists of four semesters, i.e., two years of study. So far, students have been able to choose between two branches, i.e. Power Engineering and Communications and Informatics, at enrolment in the graduate university study programme in Electrical Engineering. Students could choose between three and two elective modules in the branches Electrical Engineering and Communications and Informatics, respectively.

Pursuant to the proposed amendments to the graduate university study programme in Electrical Engineering, when enrolling in the study programme, students will be able to opt for one of the following three branches:

- EE – Power Engineering (elective modules: Electric Power Systems, Sustainable Power Systems)
- AIS – Industrial Automation
- KI – Communications and Informatics (elective modules: Communication Technologies, Network Technologies).

Based on the elected branch, a student enrols in an elective module and courses specific to that branch, as detailed below. Nonetheless, depending on the intended competencies, some courses can be taught in multiple branches. Structuring elective courses into elective modules enables a student to improve according to their interests, but on the other hand, organising several courses into an elective module enables a student to specialise in a narrower field of study.

The study programme structure with a list of courses per semester and per branch is given as follows.

Branch: Power Engineering

Semester 1:

Elective module: ELECTRIC POWER SYSTEMS	Elective module: SUSTAINABLE POWER SYSTEMS
Electricity Generation	Electricity Generation
Power System Analysis	Power System Analysis
Electric Power Transmission and Distribution	Electric Power Transmission and Distribution
Electrical Installations and Lighting Design	Electrical Installations and Lighting Design
Power Transformers and Lines	Energy Efficiency

Semester 2:

Elective module: ELECTRIC POWER SYSTEMS	Elective module: SUSTAINABLE POWER SYSTEMS
Electric Power Substations	Electric Power Substations
Renewable Electricity Sources	Renewable Electricity Sources
Economics and Electricity Market	Economics and Electricity Market
Power System Stability and Transient Processes in the Power System	Applied Power Electronics
Power Quality and Reliability in the Power System	Energy Storage and Electric Vehicles in Power Systems
Elective course*	
Energy Efficiency of Electrical Systems	
Energy Audits	
Electrical Drives	
Designing of Power Plants	
Standby Power Supply Systems	
Computing Methods and Software Support in Power Engineering	

*Students choose at least one elective course

Semester 3:

Elective module: ELECTRIC POWER SYSTEMS	Elective module: SUSTAINABLE POWER SYSTEMS
Power System Protection	Power System Protection
Power System Operation Control	Power System Operation Control
Smart Power Grids	Smart Power Grids
Project Management	Project Management
Switching Devices and High-Voltage Technology	Integration of Distributed Generation in the Power System
Elective course*	
Grounding Devices and Grounding Systems	
Electric Machines	
Thermal Applications of Renewable Energy Sources	
Power System Planning	
Electrical and Industrial Measurements	
Real-Time Simulations of Electrical Engineering Systems	
Protection Coordination of Active Power Grids	
Electromagnetic Compatibility	
Service Learning	

*Students choose at least one elective course

Semester 4:

Elective module: ELECTRIC POWER SYSTEMS	Elective module: SUSTAINABLE POWER SYSTEMS
Practical Training in Electrical Engineering	Practical Training in Electrical Engineering
Master's Thesis	Master's Thesis

Branch: Industrial Automation

Semester 1:

Branch: Industrial Automation
Electric Machines
Electromagnetic Compatibility
Electrical and Industrial Measurements
Digital Signal Processing
Industrial Informatics

Semester 2:

Branch: Industrial Automation
Basics of Robotics
Electrical Drives
Supervisory Systems in Industry
Applied Power Electronics
Design in Industrial Systems

Semester 3:

Branch: Industrial Automation
Real-Time Simulations of Electrical Engineering Systems
Dynamics of Industrial Systems
Project Management
Data-Based Modelling
Cybersecurity in Industrial Systems
Elective course*
Numerical Methods in Electromagnetism
Propulsion Systems and Power Supplies for Vehicles
Optimisations and Estimations in Electrical Engineering
Service Learning

*Students choose at least one elective course

Semester 4:

Branch: Industrial Automation
Practical Training in Electrical Engineering
Master's Thesis

Branch: Communications and Informatics

Semester 1:

Elective module: COMMUNICATION TECHNOLOGIES	Elective module: NETWORK TECHNOLOGIES
Electromagnetic Fields and Waves	Electromagnetic Fields and Waves
Computer Networks	Computer Networks
Advanced Programming	Advanced Programming
Numerical Mathematics	Digital Signal Processing
Microelectronics	Digital Image and Video Processing

Semester 2:

Elective module: COMMUNICATION TECHNOLOGIES	Elective module: NETWORK TECHNOLOGIES
Multimedia Systems	Multimedia Systems
Antennas	Codes and Coding
Optoelectronic Communications	Machine Learning
Transmitters	Object-Based Programming
Radio-Relay and Satellite Communications	Computer Systems Security

Semester 3:

Elective module: COMMUNICATION TECHNOLOGIES	Elective module: NETWORK TECHNOLOGIES
Project Management	Project Management
Mobile Communication Systems	Internet of Things
Receivers	Communication Protocols
Application of Microcontroller Systems	Mobile Communications
	Linux in Embedded Systems
Elective course*	
Digital Video Technique	Digital Video Technique

Intelligent Transportation Systems	Intelligent Transportation Systems
Service Learning	Computer Networks Design
Advanced Programming	Service Learning
Digital Image and Video Processing	Microelectronics

Semester 4:

Elective module: COMMUNICATION TECHNOLOGIES	**Elective module: NETWORK TECHNOLOGIES**
Practical Training in Electrical Engineering	Practical Training in Electrical Engineering
Master's Thesis	Master's Thesis

Notes:

- During the final semester, students enrolled in all branches have only practical training and a Master's thesis. This allows easier student mobility and the opportunity to complete their training or thesis at another institution.
- In semesters 1, 2 and 3, students enrolled in any branch can take an elective course.

4.2.1 Beginning and end of classes

The beginning and the end of each academic year are 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 enrolment requirements in the successive academic year are determined by the Ordinance on Studies and Studying of Josip Juraj 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

General and specific terms and conditions of studying defined by the Statute and the Ordinance on Studying and Studies of Josip Juraj Strossmayer University of Osijek apply to students of the graduate study programme in Electrical Engineering, 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 (European Credit Transfer and Accumulation System (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

Students can enrol in the graduate university study programme in Electrical Engineering as full-time students.

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

Students in the graduate university study programme in Electrical Engineering do not enrol in individual elective courses; instead, they opt for one of the following three branches: Power Engineering, Industrial Automation or Communications and Informatics. Within two of these branches, students may opt for elective modules Electric Power Systems and Sustainable Power Systems (in Power Engineering) and Communication Technologies and Network Technologies (in Communications and Informatics), together with associated courses. During their studies, students can also choose elective courses offered by other University constituent units.

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

Electricity Generation
Power System Analysis
Electric Power Transmission and Distribution
Electrical Installations and Lighting Design
Power Transformers and Lines
Energy Efficiency
Electric Power Substations
Renewable Electricity Sources
Economics and Electricity Market
Power System Stability and Transient Processes in the Power System
Power Quality and Reliability in the Power System
Applied Power Electronics
Energy Storage and Electric Vehicles in Power Systems
Energy Efficiency of Electrical Systems
Energy Audits
Designing of Power Plants
Standby Power Supply Systems
Computing Methods and Software Support in Power Engineering
Power System Protection
Power System Operation Control
Smart Power Grids
Switching Devices and High-Voltage Technology
Integration of Distributed Generation in the Power System
Thermal Applications of Renewable Energy Sources
Grounding Devices and Grounding Systems
Protection Coordination of Active Power Grids
Electrical Machines - Električni strojevi
Electromagnetic Compatibility
Electrical and Industrial Measurements
Digital Signal Processing
Industrial Informatics
Basics of Robotics
Electrical Drives
Supervisory Systems in Industry
Design in Industrial Systems
Real-Time Simulations of Electrical Engineering Systems
Dynamics of Industrial Systems
Project Management

Data-Based Modelling
Cybersecurity in Industrial Systems
Numerical Methods in Electromagnetism
Propulsion Systems and Power Supplies for Vehicles
Optimisations and Estimations in Electrical Engineering
Service Learning
Electromagnetic Fields and Waves
Computer Networks
Advanced Programming
Numerical Mathematics
Microelectronics
Digital Image and Video Processing
Multimedia Systems
Antennas
Codes and Coding
Optoelectronic Communications
Machine Learning
Transmitters
Object-Based Programming
Radio-Relay and Satellite Communications
Computer Systems Security
Mobile Communication Systems
Internet of Things
Receivers
Communication Protocols
Application of Microcontroller Systems
Mobile Communications
Linux in Embedded Systems
Digital Video Technique
Intelligent Transportation Systems
Computer Networks Design

4.5. Describe the process of completing the study programme.

The graduate university study programme in Electrical Engineering is completed by passing all exams, writing and defending a Master's thesis.
With the thesis, a student must demonstrate the ability to apply the knowledge gained during the studies and show that they can successfully solve tasks relevant to their profession and suitable to the academic degree they have been awarded.
Details related to writing the Master's thesis are regulated by the Faculty's Ordinance on Final Papers and Master's Theses.

4.6. Write the conditions under which students who have interrupted their studies or lost the right to study in a specific study programme can continue their studies.

The conditions under which students who have interrupted their studies or lost the right to study in a specific study programme can continue their studies are defined by the Statute, i.e. the Ordinance on Studies and Studying at J.J. Strossmayer University of Osijek. The conditions for resuming interrupted studies are stipulated by Article 37, and the conditions for completing their studies are stipulated by Article 38 of the Ordinance on Studies and Studying at Josip Juraj Strossmayer University of Osijek.

Continuation of interrupted studies (Article 37)

(1) A student who had full-time status and then lost it due to interrupting their studies may continue their education as a part-time student, provided that the study programme has not been significantly altered (more than 20%) compared to the one in which the student was enrolled.
(2) The applicant can submit a request to continue their studies if no more than three years have passed since the last academic year of study they were enrolled in and the submission of the request to continue their studies.
(3) A request for approval to continue interrupted studies is submitted to the professional council or the authorised body of the professional council on a form specially prescribed by the study programme provider, along with the student book and appropriate documentation prescribed by the study programme provider, before the enrolment deadline.
(4) Studies are continued based on the Decision on the Continuation of Interrupted Studies issued by the professional council or the authorised body of the professional council in accordance with the study programme. The decision takes into account recognised exams with grades and ECTS credits earned during the study period, as well as differential and additional exams in accordance with the study programme of the study programme provider where the student continues their education.

Completion of studies (Article 38)

(1) A person who has lost their full-time status must be allowed to complete their studies in such a way that deadlines are set from the first year of enrolment in the study programme as follows:
- for a short professional study programme within five (5) years,
- for an undergraduate university study programme and an undergraduate professional study programme within six (6) years,
- for a graduate university study programme and a specialist graduate professional study programme within four (4) years, and
- for an integrated undergraduate and a graduate university study programme within ten (10) years, in accordance with the study programme of the authorised scientific-teaching/artistic-teaching and teaching constituents for the organisation and implementation of the study programme.

(2) Individuals completing their studies pursuant to 38(1) are not entitled to students' rights and are required to pay either the full amount or a portion of the tuition fee, as specified by the Senate Decision.
(3) A person completing their studies is required to submit a request to the professional council or the authorised body of the professional council on a form specially prescribed by the study programme provider, along with the student book and appropriate documentation prescribed the study programme provider.
(4) The decision approving the completion of studies is made by the professional council or the authorised body of the professional council.
(5) The decision made by the professional council or its authorised body shall indicate recognised exams, including grades and accumulated ECTS credits earned during the study period. Additionally, it shall cover differential and additional exams as required by the study programme of the institution where the study completion was authorised. The decision shall also specify the deadlines for completing the studies and for the payment of either a portion of or the entire tuition fee, as determined by the Senate Decision.

5. APPENDICES

5.1. Decision of the Faculty Council on the launch of the amendments to the study programme

SVEUČILIŠTE JOSIPA JURJA STROSSMAYERA U OSIJEKU
FAKULTET ELEKTROTEHNIKE, RAČUNARSTVA I INFORMACIJSKIH TEHNOLOGIJA OSIJEK
JOSIP JURAJ STROSSMAYER UNIVERSITY OF OSIJEK
FACULTY OF ELECTRICAL ENGINEERING, COMPUTER SCIENCE AND INFORMATION TECHNOLOGY OSIJEK
FERIT

KLASA: 602-01/22-08/01
URBROJ: 2158-80-09-22-09
Osijek, 08. veljače 2022.

Na temelju članka 47. stavak 1. podstavka 13. Statuta Fakulteta elektrotehnike, računarstva i informacijskih tehnologija Osijek – pročišćeni tekst, Fakultetsko vijeće Fakulteta elektrotehnike, računarstva i informacijskih tehnologija Osijek, na 270. sjednici (7. sjednici Fakultetskog vijeća u akademskoj 2021./2022. godini) održanoj 08. veljače 2022. godine, pod točkom 6. dnevnog reda, donijelo je sljedeću

O D L U K U

1. Prihvaća se prijedlog izmjena i dopuna preko 20% studijskog programa **diplomskog sveučilišnog studija Elektrotehnika na Fakultetu elektrotehnike, računarstva i informacijskih tehnologija Osijek, Sveučilišta Josipa Jurja Strossmayera u Osijeku.**
2. Izmjene i dopune studijskog programa diplomskog sveučilišnog studija Elektrotehnika dostavljaju se Povjerenstvu za preddiplomske, diplomske i stručne studije Sveučilišta Josipa Jurja Strossmayera u Osijeku na daljnji postupak.
3. Ova Odluka stupa na snagu danom donošenja.

Dekan
Prof. dr. sc. Tomislav Matić

Dostaviti:
1. Povjerenstvo za preddiplomske, diplomske i stručne studije Sveučilišta Josipa Jurja Strossmayera u Osijeku
2. Pismohrana Fakultetskog vijeća
3. Pismohrana Fakulteta

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e-mail: ferit@ferit.hr | MB: 3392589 | OIB: 95494259952 | VAT ID: HR95494259952
FAKULTET ELEKTROTEHNIKE, RAČUNARSTVA I INFORMACIJSKIH TEHNOLOGIJA OSIJEK
Hrvatska poštanska banka: IBAN HR19 2390 0011 1000 1677 7 | Addiko Bank: IBAN HR6025000091 1013 7287 0

5.2. List of compulsory and elective courses with the number of contact hours required for their implementation and the number of ECTS credits.

Table 1

Branch: POWER ENGINEERING							
Year of study: 1							
Semester: 1							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[1]
Elective module: ELECTRIC POWER SYSTEMS	**Electricity Generation**	**D. Šljivac, PhD, Full Professor**	**45**	**30**	**0**	**7**	**C**
	Power System Analysis	**K. Fekete, PhD, Associate Professor**	**45**	**30**	**0**	**7**	**C**
	Electric Power Transmission and Distribution	**P. Marić, PhD, Associate Professor**	**45**	**30**	**0**	**6**	**C**
	Electrical Installations and Lighting Design	**Z. Klaić, PhD, Associate Professor**	**30**	**30**	**0**	**5**	**C**
	Power Transformers and Lines	P. Marić, PhD, Associate Professor	30	30	0	5	**C**
Elective module: SUSTAINABLE POWER SYSTEMS	**Electricity Generation**	**D. Šljivac, PhD, Full Professor**	**45**	**30**	**0**	**7**	**C**
	Power System Analysis	**K. Fekete, PhD, Associate Professor**	**45**	**30**	**0**	**7**	**C**
	Electric Power Transmission and Distribution	**P. Marić, PhD, Associate Professor**	**45**	**30**	**0**	**6**	**C**
	Electrical Installations and Lighting Design	**Z. Klaić, PhD, Associate Professor**	**30**	**30**	**0**	**5**	**C**
	Energy Efficiency	H. Glavaš, PhD, Associate Professor	30	30	0	5	C

[1]**NOTE**: If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

Branch: POWER ENGINEERING							
Year of study: 1							
Semester: 2							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[2]
Elective module: ELECTRIC POWER SYSTEMS	**Electric Power Substations**	**G. Knežević, PhD, Associate Professor**	**45**	**30**	**0**	**6**	**C**
	Renewable Electricity Sources	**Damir Šljivac, PhD, Full Professor / D. Topić, PhD, Associate Professor**	**45**	**15**	**0**	**5**	**C**
	Economics and Electricity Market	**K. Fekete, PhD, Associate Professor / G. Knežević, PhD, Associate Professor**	**45**	**15**	**0**	**5**	**C**
	Power System Stability and Transient Processes in the Power System	P. Marić, PhD, Associate Professor	30	30	0	5	C
	Power Quality and Reliability in the Power System	Z. Klaić, PhD, Associate Professor	30	30	0	5	C
	Energy Efficiency of Electrical Systems	D. Topić, PhD, Associate Professor	30	15	0	4	E
	Energy Audits	H. Glavaš, PhD, Associate Professor	30	15	0	4	E
	Electrical Drives	V. Jerković Štil, PhD, Assistant Professor / Ž. Hederić, PhD, Full Professor	45	30	0	7	E
	Designing of Power Plants	M. Stojkov*, PhD, Full Professor	30	15	0	4	E
	Standby Power Supply Systems	D. Pelin, PhD, Full Professor	30	15	0	4	E
	Computing Methods and Software Support in Power Engineering	P. Marić, PhD, Associate Professor	30	15	0	4	E
Elective module: SUSTAINABLE POWER SYSTEMS	**Electric Power Substations**	**G. Knežević, PhD, Associate Professor**	**45**	**30**	**0**	**6**	**C**
	Renewable Electricity Sources	**Damir Šljivac, PhD, Full Professor / D. Topić, PhD, Associate Professor**	**45**	**15**	**0**	**5**	**C**
	Economics and Electricity Market	**K. Fekete, PhD, Associate Professor / G. Knežević, PhD, Associate Professor**	**45**	**15**	**0**	**5**	**C**
	Applied Power Electronics	D. Pelin, PhD, Full Professor	30	30	0	5	C

[2]**NOTE**: If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

	Energy Storage and Electric Vehicles in Power Systems	D. Topić, PhD, Associate Professor	30	30	0	5	C
	Energy Efficiency of Electrical Systems	D. Topić, PhD, Associate Professor	30	15	0	4	E
	Energy Audits	H. Glavaš, PhD, Associate Professor	30	15	0	4	E
	Electrical Drives	V. Jerković Štil, PhD, Assistant Professor / Ž. Hederić, PhD, Full Professor	45	30	0	7	E
	Designing of Power Plants	M. Stojkov*, PhD, Full Professor	30	15	0	4	E
	Standby Power Supply Systems	D. Pelin, PhD, Full Professor	30	15	0	4	E
	Computing Methods and Software Support in Power Engineering	P. Marić, PhD, Associate Professor	30	15	0	4	E

Branch: POWER ENGINEERING							
Year of study: 2							
Semester: 3							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[3]
Elective module: ELECTRIC POWER SYSTEMS	**Power System Protection**	**P. Marić, PhD, Associate Professor / S. Nikolovski, PhD, Full Professor**	**45**	**30**	**0**	**6**	**C**
	Power System Operation Control	**H. Glavaš, PhD, Associate Professor**	**45**	**30**	**0**	**6**	**C**
	Smart Power Grids	**Z. Klaić, PhD, Associate Professor**	**45**	**15**	**0**	**5**	**C**
	Project Management	**D. Crnjac Milić, PhD, Full Professor**	**30**	**15**	**0**	**4**	**C**
	Switching Devices and High-Voltage Technology	G. Knežević, PhD, Associate Professor	30	30	0	5	C
	Grounding Devices and Grounding Systems	G. Knežević, PhD, Associate Professor	30	30	0	4	E
	Thermal Applications of Renewable Energy Sources	D. Topić, PhD, Associate Professor	30	30	0	4	E
	Power System Planning	K. Fekete, PhD, Associate Professor	30	30	0	4	E
	Electrical and Industrial Measurements	K. Miličević, PhD, Full Professor	45	30	0	7	E
	Real-Time Simulations of Electrical Engineering Systems	M. Barukčić, PhD, Associate Professor	45	45	0	5	E
	Electric Machines	Ž. Hederić, PhD, Full Professor / M. Barukčić, PhD, Associate Professor	30	45	0	6	E
	Protection Coordination of Active Power Grids	P. Marić, PhD, Associate Professor / S. Nikolovski, PhD, Full Professor	30	30	0	4	E
	Electromagnetic Compatibility	Z. Klaić, PhD, Associate Professor / D. Pelin, PhD, Full Professor / S. Rupčić, PhD, Full Professor	45	30	0	5	E

[3]**NOTE**: If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

	Service Learning	I. Aleksi, PhD, Associate Professor / K. Nenadić, PhD, Associate Professor / Ž. Mioković, PhD, College Professor	15	45	0	5	E
Elective module: SUSTAINABLE POWER SYSTEMS	**Power System Protection**	**P. Marić, PhD, Associate Professor / S. Nikolovski, PhD, Full Professor**	**45**	**30**	**0**	**6**	**C**
	Power System Operation Control	**H. Glavaš, PhD, Associate Professor**	**45**	**30**	**0**	**6**	**C**
	Smart Power Grids	**Z. Klaić, PhD, Associate Professor**	**45**	**15**	**0**	**5**	**C**
	Project Management	**D. Crnjac Milić, PhD, Full Professor**	**30**	**15**	**0**	**4**	**C**
	Integration of Distributed Generation in the Power System	D. Šljivac, PhD, Full Professor / Z. Klaić, PhD, Associate Professor / P. Marić, PhD, Associate Professor	45	30	0	5	C
	Grounding Devices and Grounding Systems	G. Knežević, PhD, Associate Professor	30	30	0	4	E
	Thermal Applications of Renewable Energy Sources	D. Topić, PhD, Associate Professor	30	30	0	4	E
	Power System Planning	K. Fekete, PhD, Associate Professor	30	30	0	4	E
	Electrical and Industrial Measurements	K. Miličević, PhD, Full Professor	45	30	0	7	E
	Real-Time Simulations of Electrical Engineering Systems	M. Barukčić, PhD, Associate Professor	45	45	0	5	E
	Electric Machines	Ž. Hederić, PhD, Full Professor / M. Barukčić, PhD, Associate Professor	30	45	0	6	E
	Protection Coordination of Active Power Grids	P. Marić, PhD, Associate Professor / S. Nikolovski, PhD, Full Professor	30	30	0	4	E
	Electromagnetic Compatibility	Z. Klaić, PhD, Associate Professor / D. Pelin, PhD, Full Professor / S. Rupčić, PhD, Full Professor	45	30	0	5	E
	Service Learning	I. Aleksi, PhD, Associate Professor / K. Nenadić, PhD, Associate Professor / Ž. Mioković, PhD, College Professor	15	45	0	5	E

Branch: POWER ENGINEERING							
Year of study: 2							
Semester: 4							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[4]
Elective module: ELECTRIC POWER SYSTEMS	**Practical Training in Electrical Engineering**					**10**	**C**
	Master's Thesis					**20**	**C**
Elective module: SUSTAINABLE POWER SYSTEMS	**Practical Training in Electrical Engineering**					**10**	**C**
	Master's Thesis					**20**	**C**

[4]**NOTE**: If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

Branch: INDUSTRIAL AUTOMATION							
Year of study: 1							
Semester: 1							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[5]
Industrial Automation	**Electric Machines**	**Ž. Hederić, PhD, Full Professor / M. Barukčić, PhD, Associate Professor**	**30**	**45**	**0**	**6**	**C**
	Electromagnetic Compatibility	**Z. Klaić, PhD, Associate Professor / D. Pelin, PhD, Full Professor / S. Rupčić, PhD, Full Professor**	**45**	**30**	**0**	**5**	**C**
	Electrical and Industrial Measurements	**K. Miličević, PhD, Full Professor**	**45**	**30**	**0**	**7**	**C**
	Digital Signal Processing	**I. Galić, PhD, Associate Professor**	**30**	**30**	**0**	**5**	**C**
	Industrial Informatics	**D. Slišković, PhD, Full Professor**	**30**	**45**	**0**	**7**	**C**

[5]**NOTE**: If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

Branch: INDUSTRIAL AUTOMATION							
Year of study: 1							
Semester: 2							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[6]
Industrial Automation	**Basics of Robotics**	**R. Cupec, PhD, Full Professor**	**30**	**30**	**0**	**5**	**C**
	Electrical Drives	**V. Jerković Štil, PhD, Assistant Professor / Ž. Hederić, PhD, Full Professor**	**45**	**30**	**0**	**7**	**C**
	Supervisory Systems in Industry	**K. Miličević, PhD, Full Professor / V. Jerković Štil, PhD, Assistant Professor**	**45**	**30**	**0**	**7**	**C**
	Applied Power Electronics	**D. Pelin, PhD, Full Professor**	**30**	**30**	**0**	**5**	**C**
	Design in Industrial Systems	**M. Barukčić, PhD, Associate Professor / Ž. Hederić, PhD, Full Professor**	**30**	**45**	**0**	**6**	**C**

[6]**NOTE**: If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

Branch: INDUSTRIAL AUTOMATION							
Year of study: 2							
Semester: 3							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[7]
Industrial Automation	**Real-Time Simulations of Electrical Engineering Systems**	**M. Barukčić, PhD, Associate Professor**	**45**	**45**	**0**	**5**	**C**
	Dynamics of Industrial Systems	**V. Jerković Štil, Assistant Professor**	**45**	**45**	**0**	**5**	**C**
	Project Management	**D. Crnjac Milić, PhD, Full Professor**	**30**	**15**	**0**	**4**	**C**
	Data-Based Modelling	**D. Slišković, PhD, Full Professor**	**30**	**30**	**0**	**6**	**C**
	Cybersecurity in Industrial Systems	**K. Grgić, PhD, Associate Professor** **K. Miličević, PhD, Full Professor**	**30**	**30**	**0**	**6**	**C**
	Numerical Methods in Electromagnetism	Tomislav Barić, PhD, Full Professor Željko Hederić, PhD, Full Professor	30	30	0	4	E
	Propulsion Systems and Power Supplies for Vehicles	Željko Hederić, PhD, Full Professor Denis Pelin, PhD, Full Professor	45	15	0	4	E
	Optimisations and Estimations in Electrical Engineering	M. Barukčić, PhD, Associate Professor	30	30	0	4	E
	Service Learning	I. Aleksi, PhD, Associate Professor K. Nenadić, PhD, Associate Professor Ž. Mioković, PhD, College Professor	15	45	0	5	E

[7]**NOTE:** If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

Branch: INDUSTRIAL AUTOMATION							
Year of study: 2							
Semester: 4							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[8]
Industrial Automation	**Practical Training in Electrical Engineering**					**10**	**C**
	Master's Thesis					**20**	**C**

[8]**NOTE:** If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

Branch: COMMUNICATIONS AND INFORMATICS							
Year of study: 1							
Semester: 1							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[9]
Elective module: COMMUNICATION TECHNOLOGIES	**Electromagnetic Fields and Waves**	**S. Rupčić, PhD, Full Professor**	**45**	**30**	**0**	**7**	**C**
	Computer Networks	**D. Žagar, PhD, Full Professor Krešimir Grgić, PhD, Associate Professor**	**30**	**30**	**0**	**6**	**C**
	Advanced Programming	**M. Herceg, PhD, Associate Professor J. Job, PhD, Associate Professor**	**30**	**30**	**0**	**5**	**C**
	Numerical Mathematics	A. Katić, PhD, Assistant Professor	30	30	0	5	C
	Microelectronics	D. Vinko, PhD, Associate Professor	30	45	0	7	C
Elective module: NETWORK TECHNOLOGIES	**Electromagnetic Fields and Waves**	**S. Rupčić, PhD, Full Professor**	**45**	**30**	**0**	**7**	**C**
	Computer Networks	**D. Žagar, PhD, Full Professor Krešimir Grgić, PhD, Associate Professor**	**30**	**30**	**0**	**6**	**C**
	Advanced Programming	**M. Herceg, PhD, Associate Professor J. Job, PhD, Associate Professor**	**30**	**30**	**0**	**5**	**C**
	Digital Signal Processing	I. Galić, PhD, Associate Professor	30	30	0	5	C
	Digital Image and Video Processing	M. Vranješ, PhD, Associate Professor	45	30	0	7	C

[9]**NOTE:** If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

Branch: COMMUNICATIONS AND INFORMATICS							
Year of study: 1							
Semester: 2							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[10]
Elective module: COMMUNICATIONS TECHNOLOGIES	**Multimedia Systems**	**S. Rimac-Drlje, PhD, Full Professor**	**45**	**30**	**0**	**7**	**C**
	Antennas	S. Rupčić, PhD, Full Professor	30	30	0	6	C
	Optoelectronic Communications	S. Rupčić, PhD, Full Professor	30	30	0	5	C
	Transmitters	M. Herceg, PhD, Associate Professor	45	30	0	7	C
	Radio-Relay and Satellite Communications	T. Matić (Sr.), PhD, Full Professor	30	30	0	5	C
Elective module: NETWORK TECHNOLOGIES	**Multimedia Systems**	**S. Rimac-Drlje, PhD, Full Professor**	**45**	**30**	**0**	**7**	**C**
	Codes and Coding	D. Žagar, PhD, Full Professor Krešimir Grgić, PhD, Associate Professor	45	30	0	7	C
	Machine Learning	M. Vranješ, PhD, Associate Professor	45	30	0	6	C
	Object-Based Programming	K. E. Nyarko, PhD, Associate Professor/ D. Filko, PhD, Associate Professor	30	30	0	5	C
	Computer Systems Security	K. Grgić, PhD, Associate Professor	30	30	0	5	C

[10]**NOTE:** If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

Branch: COMMUNICATIONS AND INFORMATICS							
Year of study: 2							
Semester: 3							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[11]
Elective module: COMMUNICATION TECHNOLOGIES	**Project Management**	**D. Crnjac Milić, PhD, Full Professor**	**30**	**15**	**0**	**4**	**C**
	Mobile Communication Systems	S. Rimac-Drlje, PhD, Full Professor	45	30	0	7	C
	Receivers	S. Rupčić, PhD, Full Professor	45	30	0	7	C
	Application of Microcontroller Systems	D. Vinko, PhD, Associate Professor	15	45	0	7	C
	Digital Video Technique	S. Rimac-Drlje, PhD, Full Professor	30	45	0	5	E
	Intelligent Transportation Systems	J. Balen, PhD, Associate Professor	30	30	0	5	E
	Service Learning	I. Aleksi, PhD, Associate Professor K. Nenadić, PhD, Associate Professor Ž. Mioković, PhD, College Professor	15	45	0	5	E
	Digital Image and Video Processing	M. Vranješ, PhD, Associate Professor	45	30	0	6	E
	German	I. Ferčec, MA, Senior Lecturer	30	30	0	5	O
Elective module: NETWORK TECHNOLOGIES	**Project Management**	**D. Crnjac Milić, PhD, Full Professor**	**30**	**15**	**0**	**4**	**C**
	Internet of Things	R. Grbić, PhD, Associate Professor J. Job, PhD, Associate Professor	30	30	0	5	C
	Communication Protocols	D. Žagar, PhD, Full Professor K. Grgić, PhD, Associate Professor	45	30	0	6	C
	Mobile Communications	S. Rimac-Drlje, PhD, Full Professor	45	30	0	6	C
	Linux in Embedded Systems	M. Herceg, PhD, Associate Professor R. Grbić, PhD, Associate Professor	30	30	0	4	C
	Digital Video Technique	S. Rimac-Drlje, PhD, Full Professor	30	45	0	5	E
	Intelligent Transportation Systems	J. Balen, PhD, Associate Professor	30	30	0	5	E

[11]**NOTE:** If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

	Computer Networks Design	D. Blažević, PhD, Associate Professor K. Grgić, PhD, Associate Professor	30	30	0	5	E
	Service Learning	I. Aleksi, PhD, Associate Professor K. Nenadić, PhD, Associate Professor Ž. Mioković, PhD, College Professor	15	45	0	5	E
	Microelectronics	D. Vinko, PhD, Associate Professor	30	45	0	7	E
	German	I. Ferčec, MA, Senior Lecturer	30	30	0	5	O

Branch: COMMUNICATIONS AND INFORMATICS							
Year of study: 2							
Semester: 4							
Branch	COURSE	LEAD INSTRUCTOR(S)	L	E	S	ECTS	STATUS[12]
Elective module: COMMUNICATION TECHNOLOGIES	**Practical Training in Electrical Engineering**					**10**	**C**
	Master's Thesis					**20**	**C**
Elective module: NETWORK TECHNOLOGIES	**Practical Training in Electrical Engineering**					**10**	**C**
	Master's Thesis					**20**	**C**

[12]**NOTE:** If a course is compulsory, it is labelled by C, and if it is elective, it is labelled by E.

5.3. Description and general data on each course

Branch: Power Engineering

General information		
Lead instructor(s)	Damir Šljivac, PhD, Full Professor	
Course title	Electricity Generation	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	(45+(15+15+0)+0)

1. COURSE DESCRIPTION		
1.1. Course objectives		
To acquire energy and basic techno-economic knowledge in the field of electricity generation in conventional hydroelectric power plants, thermal power plants and nuclear thermal power plants and their operation in the power system.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Assess the basic characteristics and types of power plants 2. Specify parts, energy conversions and operation of hydroelectric power plants 3. Specify the parts, energy conversions and operation of thermal power plants 4. Specify parts, energy conversions and operation of nuclear power plants 5. Analyse electrical schemes, the power plant's own consumption and work in the power system 6. Evaluate the technical and economic characteristics in the planning and construction of electricity sources 7. Evaluate real conventional power plants through practical experiences		
1.4. Course content		
Basic energy characteristics and types of conventional power plants. Hydroelectric plants: Parts of hydroelectric plants. Hydro turbines. Types of hydroelectric power plants. Characteristics of hydroelectric power plants. Adaptation of hydroelectric power plants to the load. Pumped-storage hydropower plants. Thermal power plants: Steam boiler. Steam turbine. Condensation thermal power plants. Supercritical thermal power plants. Adaptation of steam thermal power plants to the load. Cogeneration production of steam and electricity. Thermal power plants with gas turbines. Thermal power plants with a combined gas and steam turbine cycle. Impact of thermal power plants on the environment and environmental protection measures. Nuclear thermal power plants: Basic connection schemes for the production of steam in a nuclear thermal power plant. Chain reaction. Impact section. Nuclear reactor. Multiplication factor. Reactor reactivity. Types of thermal reactors. Breeding reactors. Disposal of spent fuel. Electric single-pole schemes, self-consumption and reserve power supply system of the power plant. Synchronous generator in operation: basic characteristics and operating diagrams of the generator and synchronisation with the network. Control centers and basic communication schemes for power plant management in operation. Basic techno-economic characteristics of power plants: costs of construction, operation and price of electricity production.		
1.5. Types of classes	☒ lectures	☐ individual exercises

	☐ seminars and workshops ☒ auditory exercises ☐ distance learning ☐ field work	☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.6	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	7	10
Problem-solving exercises	1.5	2, 3, 4	Revision exams (written exam)	Evaluation	12.5	25
Preparation for laboratory exercises (LE), results analysis, report writing	0.9	5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	7.5	15
Preparing for an oral exam and oral exam	3	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. L. Jozsa: Energetski procesi i elektrane, udžbenik Elektrotehnički fakultet Osijek 2006.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. P. K. Nag: Power Plant Engineering, 4th edition, McGraw-Hill Education, 2014.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
1. L. Jozsa: Energetski procesi i elektrane, udžbenik Elektrotehnički fakultet Osijek 2006.	100	60

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Krešimir Fekete, PhD, Associate Professor	
Course title	Power System Analysis	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory or elective	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+15+15+0+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To inform students of the basics of voltage regulation in radial and meshed networks. Teach students how to independently choose the appropriate method for solving power flow calculations. Make students familiar with the calculation of short circuits in power networks and train them how to calculate short circuit currents numerically as well as by using a computer.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled		
1.3. Expected learning outcomes		
1. Analyse and model the elements of the electric power network for voltage regulation calculations. 2. Create a network model for power flow and fault calculations in the network. 3. Identify and calculate network matrices, as well as admittance and impedance matrices. 4. Assess voltage conditions and power flows in the power system. 5. Select and evaluate mathematical procedures for calculating power flows depending on the network conditions. 6. Calculate fault currents for different types of short circuits. 7. Choose appropriate methods for short-circuit calculation depending on the type of fault and network conditions 8. Assess the security state of the power system.		
1.4. Course content		
Voltage regulation in the network: Nominal voltage and deviations from the nominal voltage. Voltage changes over time. Voltage drop. Actions to maintain voltage in the network. Regulation of voltage magnitude and voltage angle. Maintenance of correct voltage regime. Performing voltage regulation on network elements with special reference to renewable energy sources. Reduction of reactive power in the network. Actions for reactive power compensation. Power flows in the network: Mathematical model of the electrical network. Equations for node powers and power flows. Classification of nodes. Calculation of power flows using the Gauss-Seidel and Newton-Raphson methods. Short circuit: Short circuit basics. Earthing of the three-phase network. Calculation of short-circuit current. Matrix method for calculation of short-circuit current applied on a computer. The role of renewable energy sources in the short-circuit calculation. Analysis of power system stability.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops	☐ individual exercises ☐ multimedia and network

	☒ auditory exercises ☒ distance learning ☐ field work	☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE).	2.5	1, 2, 3, 4, 5, 6 ,7	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Problem-solving exercises	1	3, 5, 6	Revision exams (written exam)	Evaluation	20	40
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	1, 4, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	5	10
Preparing for an oral exam and oral exam	2	1, 2, 5, 7, 8	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. L. Jozsa Tokovi snaga u mreži, ETF Osijek
2. M. Ožegović i K. Ožegović Električne energetske mreže IV i V
3. S. Nikolovski i D. Šljivac Elektroenergetske mreže (zbirka zadataka)

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

Glover, J.D; Overbye, T; M.S.; Sarma Power System Analysis and Design, 6th Edition

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
L. Jozsa Tokovi snaga u mreži, ETF Osijek	10	40
M. Ožegović i K. Ožegović Električne energetske mreže IV i V	20	40
S. Nikolovski i D. Šljivac Elektroenergetske mreže (zbirka zadataka)	10	40

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Predrag Marić, PhD, Associate Professor	
Course title	Electric Power Transmission and Distribution	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+15+0)+0

1. COURSE DESCRIPTION

1.1. Course objectives

Acquisition of the aspects of electric power transmission and distribution with the calculation and simulation of characteristic operating conditions, and the application of the principle of power system component selection.

1.2. Course enrolment requirements

Requirements for enrolment in the study programme fulfilled.

1.3. Expected learning outcomes

1. Classify topological configurations of transmission and distribution grids.
2. Calculate the current-voltage condition of the transmission and distribution grid.
3. Apply the selection criteria of distribution lines and transformers.
4. Create a transmission and distribution grid model in the simulation interface for the analysis of stationary and transient operating states.
5. Analyse aspects of the stability of the transmission grid.
6. Analyse the influence of the integration of RES power plants and different types of consumers on operating characteristics of distribution grid.

1.4. Course content

Analysis of configurations of conventional transmission systems and HVDC systems. Voltage and frequency stability in transmission grid, low-frequency oscillations of active power on transmission lines. The influence of RES power plants on the current-voltage conditions of the transmission grid. Implementation of FACTS devices and WAMS systems in transmission grid. Topologies of distribution grid- calculation of current-voltage conditions, reliability, and principles protection of different topological configurations. Grounding of distribution grids Distribution transformers- types, connection groups, rated power, techno-economic calculation. Criteria for selection of distribution lines. Analysis and load planning of distribution grids. The influence of the integration of RES power plants, and non-linear and unbalanced consumers on the operating characteristics of distribution grid. Definition of the microgrid.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____

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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.5	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Problem-solving exercises	1.5	1, 2, 3	Revision exams (written exam)	Evaluation	25	50
Preparation for laboratory exercises (LE), results analysis, report writing	1	1, 4	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	5	10
Preparing for an oral exam and oral exam	2	1, 3, 5, 6	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Sivanagaraju, S. Electric Power Transmission and Distribution, Pearson – India 2017.
2. A Grigsby, Leonard L., Electric power generation transmission and distribution, 3rd edition, Boca Raton; CRC Press, 2012.
3. Štefić, B; Nikolovski, S. Prijenos i distribucija el. Energije, Osijek, Elektrotehnički fakultet
4. S. Nikolovski, D. Šljivac Elektroenergetske mreže - Zbirka zadataka, Osijek, Elektrotehnički fakultet

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. J. Karlo i Marija Ožegović Elektroenergetske mreže III, IV, V
2. Singh, S.N. Electric power generation, transmission and distribution, 2th ed., Delhi; PHI learning, 2015.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Sivanagaraju, S. Electric Power Transmission and Distribution, Pearson – India 2017.	1	45
A Grigsby, Leonard L., Electric power generation transmission and distribution, 3rd edition, Boca Raton; CRC Press, 2012.	3	45
S. Nikolovski, D. Šljivac Elektroenergetske mreže - Zbirka zadataka, Osijek, Elektrotehnički fakultet	5	45

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Zvonimir Klaić, PhD, Associate Professor	
Course title	Electrical Installations and Lighting Design	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Present to students the rules for designing electrical installations and indoor and outdoor lighting, as well as lighting efficiency measures.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Define parts of technical documentation. 2. Classify laws, norms and regulations (Construction Act, Technical regulations for low-voltage electrical installations). 3. Explain the most important requirements regarding the design of electrical installations, the design of external and internal lighting, the design of fire protection, and the requirements for lighting efficiency measures. 4. Make a calculation of the voltage drop and the selection of the cross-section of the connecting conductors, as well as a calculation of protection against indirect contact, a calculation of the basic energy consumption for the lighting system, and a calculation of the lighting efficiency. 5. Create a low-voltage installation project and an external or internal lighting project.		
1.4. Course content		
Modern technical documentation, laws, norms and regulations, Construction Act, Technical regulation for low-voltage electrical installations, circuit schemes and diagrams, rules for designing low-voltage electrical installations, fire protection, rules for designing indoor and outdoor lighting, methods for lighting efficiency, light pollution.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☒ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	0.5	1, 2, 3	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	7	10
Problem-solving exercises	1.5	4	Revision exams (written exam)	Evaluation	15	30
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	30
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 4, 5	Oral exam	Evaluation	15	30

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Stojkov, M; Šljivac, D; Topić, D; Trupinić, K; Alinjak, T; Arsoski, S; Klaić, Z; Kozak, D. Energetski učinkovita rasvjeta
2. V. Srb, Električne instalacije i niskonaponske mreže, Tehnička knjiga, Beograd, 1991.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Zakon o gradnji, NN 125/19
2. Tehnički propis za niskonaponske električne instalacije, NN 5/2010
3. E. Širola, Cestovna rasvjeta, ESING, Zagreb, 1997.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
1. Stojkov M; Šljivac, D; Topić, D ;Trupinić, K.; Alinjak, T; Arsoski, S; Klaić, Z; Kozak, D. Energetski učinkovita rasvjeta	3	
2. V. Srb, Električne instalacije i niskonaponske mreže, Tehnička knjiga, Beograd, 1991.	1	

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Predrag Marić, PhD, Associate Professor	
Course title	Power Transformers and Lines	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Acquisition of theoretical and practical knowledge in the field of power transformers and lines.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Describe the physical basis of power transformers, types of power transformers and types of operation. 2. Classify the mechanical and electrical properties of overhead lines. 3. Apply the equivalent scheme and phasor diagram of power transformers and lines. 4. Apply the basic principles of designing power transformers and sizing lines. 5. Create calculations and simulations of permissible heating and characteristic sizes of transformers and lines in different operating conditions. 6. Analyse the operation of the power transformer in stationary and transient states.		
1.4. Course content		
Physical foundations of power transformers - application of the theory of electromagnetism. An ideal and the perfect transformer, dissipation, magnetizing current - harmonic analysis of magnetizing current. Losses in iron, initial magnetisation curve, hysteresis loop, remanent current, saturation, analysis of transformer inrush current. Losses in copper, short-circuit voltage, Kapp triangle, equivalent scheme and phasor diagram of a real transformer in different operating conditions. Transformer designs, connection groups, heat transfer, types of operation, winding aging. Voltage regulation, parallel operation. Basic principles of transformer design. Higher harmonics, the appearance of the third harmonic in different connection groups and different designs of the transformer core. Materials, designs and sizing of overhead lines and cables. Voltage drop calculation, heat calculation, short- circuit calculation of the lines. Mechanical calculation of conductors of overhead line. Types of insulators and towers. Earthing of overhead and cable lines.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____

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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Problem-solving exercises	1	3, 4, 5	Revision exams (written exam)	Evaluation	25	50
Preparation for laboratory exercises (LE), results analysis, report writing	1	4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	5	10
Preparing for an oral exam and oral exam	1	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. A. Dolenc Transformatori I i II dio, Zagreb : Sveučilišna naknada, 1991
2. HARLOW, H. JAMES, Electric power transformer engineering, Boca Raton, CRC Press, 2012
3. L. Jozsa Parametri nadzemnih vodova, 2014.
4. L. Jozsa Nadzemni vodovi, Osijek, ETF, 1995
5. V. Srb Kabelska tehnika, priručnik

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Mirošević, G.; Vidaković, F. Projektiranje, gradnja i održavanje dalekovoda, Kigen, 2008.
2. Mitraković, B., Transformatori, 8. izdanje

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
A. Dolenc, Transformatori I i II dio, Zagreb : Sveučilišna naknada, 1991	9	23
Harlow, H. James, Electric power transformer engineering, Boca Raton, CRC Press, 2012	1	23
L. Jozsa, Parametri nadzemnih vodova, 2014.	3	23
L. Jozsa, Nadzemni vodovi, Osijek, ETF, 1995	37	23

Mirošević, G.; Vidaković, F. Projektiranje, gradnja i održavanje dalekovoda, Kigen, 2008.	Free online access	23
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Hrvoje Glavaš, PhD, Associate Professor	
Course title	Energy Efficiency	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Introduce students to the meaning of the term energy efficiency and its historical development. Based on the classification of specific areas of energy efficiency analysis, a detailed analysis of each area will be performed. A detailed analysis includes: building construction as the largest sector of primary energy consumption, transport sector and public lighting. After the adopted basics, attention is paid to energy balancing and problems arising from the area of improving energy efficiency. Using the example of lighting, the paradox of increased consumption due to increased efficiency is analysed.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Explain and describe the concept of energy efficiency. 2. Analyse areas of application of energy efficiency. 3. Analyse the energy balance. 4. Create a methodological framework for the analysis of Jevonson's paradox. 5. Create a proposal for optimal measures to improve energy efficiency. 6. Analyse energy needs in buildings. 7. Calculate the economic aspects of energy efficiency measures and the energy class.		
1.4. Course content		
Energy efficiency is a way of achieving energy independence. The course analyses measures of energy efficiency through: efficiency of primary energy conversion, efficiency of conversion in immediate consumption and energy savings through reduction of consumption. The energy consumption review, using primary energy factors, determines the primary energy needs of each consumer. It presents legal frameworks and EU recommendations related to energy efficiency. The practical use of acquired knowledge is carried out through an individual project of energy inspection of housing and determination of energy class.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____

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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	0.5	1, 2, 3, 4, 5	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	10
Problem-solving exercises	1	3	Revision exams (written exam)	Evaluation	10	20
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	3	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	0	20
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 4, 5	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. HRN EN 16247, General requirements (EN 16247-1:2012), Buildings (EN 16247-2:2014), Processes (EN 16247-3:2014), Transport (EN 16247-4:2014), Competences of energy auditors (EN 16247-5:2015)
2. Handbook for energy certification of buildings, UNDP, Zagreb 2010.
3. Handbook for energy certification of buildings - Part 2, UNDP, Zagreb 2012.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Ministry of Spatial Planning, Construction and State Property, Methodology for Conducting Energy Inspection of Buildings
2. Energy Efficiency Act (NN 127/14, NN 116/18, NN 25/20, NN 41/21)
3. Energy Management Handbook, seventh edition, CRC press, 2009.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
HRN EN 16247	5	20
Handbook for energy certification of buildings, UNDP, Zagreb 2010.	2	20
Handbook for energy certification of buildings - Part 2, UNDP, Zagreb 2012.	2	20

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Goran Knežević, PhD, Associate Professor	
Course title	Electric Power Substations	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+15+15+0+0

1. COURSE DESCRIPTION

1.1. Course objectives

Explain to students the elements of electric power substations.
Train students to design, maintain and manage electric power substations.

1.2. Course enrolment requirements

Requirements for enrolment in the study programme fulfilled.

1.3. Expected learning outcomes

1. Categorise the elements of the electric power substation and their purpose.
2. Compare the basic schemes of electric power substations.
3. Recognise the elements of the substation and the way they are connected in the bay.
4. Calculate short-circuit currents and forces acting on substation elements.
5. Select the elements of the electric power substation according to current-voltage loads, forces acting on the elements and thermal loads.
6. Distinguish the mechanisms of current arc extinguishing with regard to the technology of the switching equipment.
7. Design the grounding system of the electric power substation.
8. Identify and apply models of all elements in the electric power substation.
9. Calculate the properties of the electric power substation using appropriate software packages for network modelling and short-circuit calculation.
10. Justify the use of electrical equipment on specific electric power substation examples.

1.4. Course content

Electric power substation in general. Electric power substation structure (primary and secondary equipment). Substation classification. Impacts on and from the substation. Voltage stresses and insulation coordination. Current stresses. Short-circuit currents in the plant. Calculation of thermal loads. Calculation of forces acting on substation elements. Elements of the primary substation (busbars and non-insulated conductors, insulators, power cables, circuit-breakers, disconnectors, MV fuses, current measuring transformers, voltage measuring transformers, power transformers, inductors, capacitors, surge arresters). Schemes, dispositions and constructions of the substation. Grounding and grounding devices in power substation. Lightning protection in substation. Auxiliary subsystems (signalling, measurement, protection, control, interlock, regulation, local automation, registration, remote control, power supply). Calculation of the reliability of power substations. Requirements for the design and use of the substation. Construction, operation and maintenance of the substation. Proceedings in the event of an accident in the substation. Protection at work in the substation. Gas-insulated, metal-shielded substations.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 5, 9	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Problem-solving exercises	1.5	5, 8, 9	Revision exams (written exam)	Evaluation	20	40
Preparation for laboratory exercises (LE), results analysis, report writing	1	4, 5, 6, 7, 8	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	5	10
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 5, 9	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. H. Požar, Visokonaponska rasklopna postrojenja, Tehnička knjiga - Zagreb, 1967.
2. Elektroenergetska postrojenja, FERIT Osijek, textbook (in preparation)

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. J. D. McDonald, Electric Power Substations Engineering, CRC Press, 2003.
2. B. Belin, Uvod u teoriju električnih sklopnih aparata, Školska knjiga-Zagreb, 1987.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*

H. Požar, Visokonaponska rasklopna postrojenja, Tehnička knjiga - Zagreb, 1967.	2	45
Elektroenergetska postrojenja, FERIT Osijek, textbook (in preparation)	2	45
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Damir Šljivac, PhD, Full Professor, Danijel Topić, PhD, Associate Professor	
Course title	Renewable Electricity Sources	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To acquire energy and basic techno-economic knowledge in the field of electricity generation in power plants from renewable energy sources and their design.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Specify all essential technical and technological characteristics of power and cogeneration plants on RES. 2. Assess the profitability of building power plants and cogeneration plants on RES. 3. To design the electrical part of power plants and cogeneration plants on RES. 4. Evaluate the basic characteristics of power and cogeneration plants based on renewable energy sources. 5. Independently measure and analyse electrical quantities in RES plants. 6. Evaluate real RES plants through practical experiences.		
1.4. Course content		
Basic characteristics and division, valid legislation and current status of power plants and cogeneration plants on RES. Biomass and biogas cogeneration plants. Wind power plants. Thermal power plants with concentrated solar radiation. Photovoltaic systems. Geothermal power plants. Small hydropower plants. Electrical schemes and the basic impact of certain technologies on the power system. Techno-economic characteristics and profitability of electricity production from power plants and cogeneration plants using renewable energy sources. Designing power plants and cogeneration plants on RES.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	0.6	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	7	10
Problem-solving exercises	1.5	3, 4	Revision exams (written exam)	Evaluation	12,5	25
Preparation for laboratory exercises (LE), results analysis, report writing	0.9	3, 5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	7,5	15
Preparing for an oral exam and oral exam	2	1, 2, 3, 4	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. D. Šljivac, D. Topić Obnovljivi izvori električne energije, sveučilišni užbenik, FERIT Osijek, 2018.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. G.M. Masters: Renewable and Efficient Electric Power Systems, 2nd edition J. Wiley & Sons, 2022
2. L. Jozsa: Energetski procesi i elektrane, sveučilišni, užbenik FERIT Osijek, 2006.
3. T. Ackermann: Wind Power in Power System, 2nd edition, J. Wiley & Sons, 2012
4. Kaltschmitt, Martin, Streicher, Wolfgang, Wiese, Andreas (Eds) Renewable Energy Technology, Economics and Environment, Springer, 2007
5. Hartung, Katalin; Horeczki, Réka; Klaić, Zvonimir; Kovács Sándor Zsolt; Pallós Balázs; Pelin, Denis; Primorac, Mario; Póla, Péter; Šljivac, Damir; Suvák, Andrea et al.: Regional Impacts of Different Photovoltaic Systems, Pecs: IDResearch kft./Publikon Kiado Pecs, 2014

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
1. D. Šljivac, D. Topić Obnovljivi izvori električne energije, sveučilišni užbenik, FERIT Osijek, 2018.	100	50

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Krešimir Fekete, PhD, Associate Professor, Goran Knežević, PhD, Associate Professor	
Course title	Economics and Electricity Market	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory or elective	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+0+15+0+0

1. COURSE DESCRIPTION
1.1. Course objectives
Introduce students to the implementation of techno-economic analysis in the electric power system under market conditions. Show students the existing architecture of the electricity market. Explain to students the roles and behaviours of different market participants (producers, buyers, transmission and distribution companies) in different market conditions. Analyse the role of renewable energy power plants in market conditions.
1.2. Course enrolment requirements
Requirements for enrolment in the study programme fulfilled.
1.3. Expected learning outcomes
1. Explain the basic concepts of engineering economics (interest account and assessment investment profitability). 2. Determine the structure of the electricity market (supply and demand, formation of market prices, theoretical and practical performance of the electricity market). 3. Analyse and compare legal frameworks related to the electricity market in countries of the European Union. 4. Calculate and compare the costs of construction, operation and maintenance of electric power plants (conventional and RES) . 5. Analyse the method of levelised cost of electricity (LCOE). 6. Evaluate different methods of engineering economy for cost-effectiveness calculation investments in different elements of the power system. 7. Compare the behaviour of market participants (producers, buyers and transmission and distribution companies) in the market conditions on the theoretical and practical level. 8. Create a simulation of the use of market power in the electricity market. 9. Evaluate different methods of managing the transmission network in the case of congestion. 10. Analyse different systems of incentives for the construction of RES power plants.
1.4. Course content
Introduction to engineering economics (interest calculation, cost theory and investment profitability assessment). Cost characteristics of electricity production (conventional and RES) and levelised cost of electricity production (LCOE) for different electric power plant. Introduction to the electricity market (economic fundamentals of the electricity market, types of market contracts, deregulation and restructuring of the electricity sector, market participants). Electricity market architecture – theoretical models (bilateral and pool model, auxiliary services market) and practical implementations (NordPool, EEX, PJM). Transmission and distribution network in market conditions – transmission and distribution tariffs, different models of transmission (TSO, ITO, NTSO) and distribution companies, transmission network management in case of

congestion. Market power - perfectly and imperfectly competitive markets, monopolies and oligopolies, indices for showing market concentration (market share, HHI), indices for showing the behaviour of market participants (Lerner's index), tools for analysis and simulation of market power. The legal framework of the electricity market in the Republic of Croatia and the EU - an overview of legal and sub-legal acts of the Republic of Croatia and the EU (directives and regulations). Renewable energy power plants in a market environment.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Solving the project task	1	4, 7, 8	Evaluation of solutions	Evaluation	10	20
Preparation for laboratory exercises (LE), results analysis, report writing	1	2, 7, 8, 9	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	30
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 5, 9, 10	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Nikolovski, S; Fekete G;. Knežević i Z. Stanić Uvod u tržište električne energije, Grafika Osijek, 2010.
2. Kirschen, D.S; Strbac, G. Fundamentals of Power System Economic

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. M. Shahidehpour, H. Yaminand Z. Li Market Operationsin Electric Power System – Forecasting, Scheduling and Risk Management

2. M. Greer Electricity cost modeling calculations
3. S. Stoft Power System Economics – Designing Markets for Electricity

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Nikolovski, S; Fekete G; Knežević and Z. Stanić. Uvod u tržište električne energije, Grafika Osijek, 2010.	2	45
Kirschen, D.S; Strbac, G. Fundamentals of Power System Economic	2	45

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Predrag Marić, PhD, Associate Professor	
Course title	Power System Stability and Transient Processes in the Power System	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+15+0)+0

1. COURSE DESCRIPTION

1.1. Course objectives

Acquisition of power system stability and transient states analysis methods with simulations of characteristics variables in the simulation interface.

1.2. Course enrolment requirements

Requirements for enrolment in the study programme fulfilled.

1.3. Expected learning outcomes

1. Classify the methods for the analysis of power system transient states.
2. Categorise the power system stability.
3. Interpret the criteria of frequency stability, voltage stability and rotor angle stability.
4. Calculate the characteristic variables in the transition states of the power system, sketch the active power, rotor angle, generator speed diagrams, P-V and Q-V curves, and root locus.
5. Create an adequate simulation model for analysis of characteristic variables in transient states and perform simulations.
6. Analyse the influence of AVR, turbine and governor, inverters, FACTS devices, and renewable energy sources on power system stability.

1.4. Course content

Modelling and analysis of the operation of power system components in transient states. The connection of the generator to the grid, synchronisation criteria, asynchronous operation, resynchronisation, and synchronous generator models for stability analysis. Power system stability classification, concept of inertia in power system. Frequency stability, the influence of integration of RES on inertia, and frequency stability. Voltage stability - large and small disturbances, dQ/dV criterion, dE/dV criterion, Q-V curves, P-V curves, the influence of AVR on voltage stability, voltage breakdown, and the impact of RES integration. Rotor angle stability: transient stability – equal area criterion, critical angle and critical short-circuit clearing time, influence of AVR, turbine and governor, FACTS devices, and integration of RES on transient stability. Oscillatory stability – synchronising and damping torque of synchronous generator, monotonic, and oscillatory modes. Classification of oscillatory modes. Modal analysis, participation factors, and improvement of oscillatory stability. Basics of PSS tuning. Analysis of the influence of RES integration on oscillatory stability.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises

	☒ distance learning ☐ field work	☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work		
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 student work during classes and in the final exam		

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Problem-solving exercises	1	3, 4	Revision exams (written exam)	Evaluation	25	50
Preparation for laboratory exercises (LE), results analysis, report writing	1	1, 2, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	5	10
Preparing for an oral exam and oral exam	1	1, 2, 3, 6	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. J. Machowski, J. W. Bialek, J. R. Bumby, Power System Dynamics: Stability and Control - Second Edition,2008
2. Paul M. Anderson, A. A. Fouad Power System Control and Stability, Second Edition, IEEE Press, 2003
3. Gibbard, M.J; Pourbeik, P; Vowles, D.J. Small-signal stability, control and dynamic performance of power systems

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. J.Machowski, Z. Lubosny, J. W. Bialek, J. R. Bumby, POWER SYSTEM DYNAMICS Stability and Control -3rd Edition,2020
2. A.A. Sallam, Om P. Malik, Power System Stability Modelling, analysis and control, The institution of Engineering and Technology, 2015

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
J.Machowski, J. W. Bialek, J. R. Bumby, Power System Dynamics Stability and Control - Second Edition,2008	1	20
Paul M. Anderson, A. A. Fouad Power System Control and Stability, Second Edition, IEEE Press, 2003	1	20
Gibbard, M.J; Pourbeik, P; Vowles, D.J. Small-signal stability, control and dynamic performance of power systems, 2015	Free online access	20
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Zvonimir Klaić, PhD, Associate Professor	
Course title	Power Quality and Reliability in the Power System	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Present to students voltage quality standards, voltage quality indices, power quality analysis and applications in the power system. Present to students probability distributions of events in EES, reliability indicators of distribution and transmission networks, and electricity production systems.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Classify international and European standards for the power quality and Grid Codes of the electricity system. 2. Explain voltage quality indices, their causes and consequences, and methods for improvement. 3. Evaluate and interpret the results of measuring and monitoring of the the power quality. 4. Estimate the annual number of voltage dips due to short circuits in part of the power system, and estimate the resulting annual cost. 5. Describe probability distributions of stochastic events in the power system as well as Markov models of components and their states. 6. Define reliability models of production, transmission and distribution systems, as well as reliability models of smart grids. 7. Analyse and evaluate reliability indicators of production, transmission and distribution systems, and of smart grids, using the state space method		
1.4. Course content		
Voltage quality standards, voltage quality indices: voltage fluctuations and flickers, voltage dips and interruptions, surges and overvoltages, harmonics, voltage asymmetry. Analysis of the results of measurement and monitoring of power quality. Stochastic assessment of voltage dips due to short circuits in the power system. Economic effects of poor power quality. The influence of renewable energy sources on the power quality. Power quality in smart grid. Probability distributions of power system operating states. Markov models of state space and probability, frequency and duration of interruptions for serial, parallel and mixed connection of components. Models of renewable and non-renewable power system components, state models of the production system – conventional and renewable energy sources (operation, failure, overhaul, planned shutdown, reduced capacities), state models of consumption. Indicators of the reliability of the production system, indicators of the reliability of transmission, distribution and smart grid, indicators of the reliability of the entire power system.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops	☐ individual exercises ☐ multimedia and network

	☒ auditory exercises ☒ distance learning ☐ field work	☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	0.25	1, 2, 3, 4, 5, 6, 7	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	3	5
Problem-solving exercises	0.75	3, 4, 5, 6	Revision exams (written exam)	Evaluation	8	15
Preparation for laboratory exercises (LE), results analysis, report writing	1	3	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Preparing for an oral exam and oral exam	3	1, 2, 3, 4, 5, 6, 7	Oral exam	Evaluation	30	60

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Tokić, A; Milardić, V. Kvalitet električne energije
2. Chowdhury, Ali ; Don Kova Power Distribution System Reliability: Practical Methods and Applications.
3. l. Baggini, A. Handbook of Power Quality
4. Zvonimir Klaić Mjerenje i analiza kvalitete električne energije u distribucijskoj mreži prema EN 50160

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. HRN EN 50160:2012, Naponske karakteristike električne energije iz javnog distribucijskog sustava

2. IEEE std 1159-1995 – IEEE Recommended Practice for Monitoring Electric Power Quality, IEEE Standards Board, 1995.

3. EURELECTRIC: Power Quality in European Electricity Supply Networks, Brussels, 2002.

4. Ph. Feracci: Cahier Technique no. 199 – Power Quality, Schneider Electric, 2001.

5. V. Mikuličić, Z- Šimić. Modeli pouzdanosti i raspoloživosti i rizika u EES-u I dio, Kigen, 2008

6. R. Billinton, R.N: Allan. Reliability Assesment of Large Electric Power Systems. Kluwer Academic Publisher 1988		
1.12. Number of obligatory literature copies in relation to the number of students currently taking the course		
Title	*Number of copies*	*Number of students*
1. Tokić, A; Milardić, V. Kvalitet električne energije	1	25
2. Chowdhury, Ali; Don Kova Power Distribution System Reliability: Practical Methods and Applications.	1	25
3. l. Baggini, A. Handbook of Power Quality	1	25
4. Zvonimir Klaić. Mjerenje i analiza kvalitete električne energije u distribucijskoj mreži prema EN 50160	2	25
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Danijel Topić, PhD, Associate Professor	
Course title	Energy Efficiency of Electrical Systems	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Introduce students to measures for improving the energy efficiency of electrical systems. Present measures for improving the energy efficiency of electrical systems in industrial facilities. Present measures for improving the energy efficiency of power systems. Present measures for improving the energy efficiency of electrical systems in motor drives. Present measures for improving the energy efficiency of electrical lighting.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled		
1.3. Expected learning outcomes		
1. Categorise electrical systems. 2. Describe measures for improving energy efficiency. 3. Propose energy efficiency measures. 4. Calculate the energy savings achieved through the implementation of energy efficiency measures. 5. Assess the savings achieved from specific energy efficiency measures.		
1.4. Course content		
Legal regulations related to energy efficiency with a focus on electrical energy. Introduction to energy efficiency measures in electrical systems. Energy efficiency in industrial facilities. Measures to improve energy efficiency in electrical systems within industrial facilities. Energy efficiency of power systems. Measures to improve energy efficiency in power systems. Energy efficiency of motor drives. Measures to improve energy efficiency in motor drives. Energy efficiency of electrical lighting. Measures to improve the energy efficiency of electrical lighting systems. Reactive power compensation. Energy management systems.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☒ individual exercises ☐ multimedia and network ☐ laboratory exercises ☒ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 5	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	10
Preparation for laboratory exercises (LE), results analysis, report writing	0.5	3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	20	40
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 4, 5	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Sumper, A.; Baggini, A. Electrical energy efficiency: Technologies and application, Wiley, 2012.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Energy Management Handbook, seventh edition
2. L. Halonen, E. Tetri, P. Bhusal Guidebook on Energy Efficient Electric Lighting for Buildings
3. UNDP - Handbook for Energy Advisors

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
1. Sumper, A.; Baggini, A. Electrical energy efficiency: Technologies and application, Wiley, 2012.	2	18

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Hrvoje Glavaš, PhD, Associate Professor	
Course title	Energy Audits and Public Lighting	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Elective	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+0+15)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Make students familiar with the implementation of energy audits, emphasising energy audits of public lighting. The goal of the course is to expand the knowledge about the implementation of the energy audit of public lighting through a detailed analysis of individual items of the methodology, taking into account its specificity. In addition to the analysis, the course provides basic information on the design of public lighting so that realistic measures of energy efficiency could be proposed.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Explain and describe the energy audit implementation procedure. 2. Understand the functioning of the basic elements of the public lighting system. 3. Analyse the collected data and create a report on the implementation of the energy audit. 4. Create a proposal for technical solutions to improve energy efficiency. 5. Create solutions to improve energy efficiency.		
1.4. Course content		
Energy audits are an integral part of the implementation of part of the energy policy of the European Union. The aim of the course is to acquaint students with the process of implementing an energy audit of public lighting through an analysis of the energy balance in accordance with the national methodology. For the purposes of the analysis, it is necessary to acquire basic knowledge about the basic elements and design of public lighting in order to be able to propose technical solutions for improving energy efficiency and to choose optimal solutions for improving energy efficiency.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.5	1, 2, 3, 4, 5	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	10
Problem-solving design exercises (DE)	1	2, 3, 4	Design exercises (DE)	Evaluation	0	40
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 4, 5	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. EN 13201 Road lighting -- Part 1: Selection of lighting classes, Part 2: Required properties, Part 3: Calculation of properties, Part 4: Methods of measuring lighting properties, Part 5: Indicators of energy properties
2. Eduard Širola, Road lighting, Esing, 1997. ISBN-953964816

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Ministry of Spatial Planning, Construction and State Property, Methodology for Conducting Energy Inspection of Buildings
2. Energy Efficiency Act (NN 127/14, NN 116/18, NN 25/20, NN 41/21)
3. Lighting technical manual - Catalog of energy-efficient lighting, January 2013.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
HRN EN 16247	1	14
Eduard Širola, Road lighting, Esing, 1997. ISBN-953964816	1	14

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Vedrana Jerković Štil, PhD, Assistant Professor, Željko Hederić, PhD, Full Professor	
Course title	Electrical Drives	
Study programme	Graduate university study programme in Electrical Engineering, branches: Power Engineering and Industrial Automation	
Course status	Compulsory, branch: Industrial Automation, Elective, branch: Power Engineering	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+30+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Present the electrical drives control methodology and specifics to students. Inform students about dynamic models of electrical machines as fundamental parts of controlled electrical drives. Familiarise students with vector control of alternating current electrical machines. Present the methods of torque and position control of electrical drives. Familiarise students with computer based modelling and simulation. Present electric drives for electric vehicles and control of diesel power generators.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Build dynamical models of DC motor, induction motor and synchronous generator. 2. Create simulation models of controlled electrical drives. 3. Select the optimal parameters for controllers in DC, induction and synchronous electrical drive. 4. Analyse the block diagrams of torque and position control of electrical drives. 5. Analyse the simulation models of electrical drives with various load types. 6. Classify electrical dries for electric vehicles. 7. Identify the diesel power generator drive specifics.		
1.4. Course content		
Electric drives specifics and control systems. Dynamic models of DC machine, induction machine and synchronous generator. Speed control of separately excited DC motor. Speed vector control for AC machines. Torque and position control of electric drive. Modelling and simulation of electric drives with computers. Control simulation with motor loads. Electric vehicle drives. Diesel power generators.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2.5	1, 2, 3, 4, 5, 6, 7	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	10
Problem-solving exercises	1.5	3, 4, 7	Revision exams (written exam)	Evaluation	15	30
Preparation for laboratory exercises (LE), results analysis, report writing	1.2	1, 2, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Preparing for an oral exam and oral exam	1.8	4, 5, 6, 7	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. M. Jadrić, B. Frančić: Dinamika električnih strojeva, Graphis, Zagreb, 1995.
2. W. Leonhard: Control of Electrical Drives, Springer, 1996.
3. V. Ambrožić, P. Zajec: Električni servo pogoni, Graphis, Zagreb, 2019.
4. B. Jurković: Elektromotorni pogoni, ŠK, Zagreb, 1990.
5. S. Soylu: Electric Vehicles - Modelling and Simulations, Open access peer, Online

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Danfoss: Najvažnije o frekvencijskim pretvaračima, Graphis, Zagreb,2009.
2. P. Krause: Analysis of electric machinery and drive systems, Wiley, 2013.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
M. Jadrić, B. Frančić: Dinamika električnih strojeva, Graphis, Zagreb, 1995.	3	15
W. Leonhard: Control of Electrical Drives, Springer, 1996.	3	15
V. Ambrožić, P. Zajec: Električni servo pogoni, Graphis, Zagreb, 2019.	2	15
B. Jurković: Elektromotorni pogoni, ŠK, Zagreb, 1990.	2	15
S. Soylu: Electric Vehicles - Modelling and Simulations	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Marinko Stojkov, PhD, Full Professor	
Course title	Designing of Power Plants	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Elective	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+0+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Acquaintance with basic knowledge of power plant design.		
1.2. Course enrolment requirements		
Requirements for enrolment in the first year of study fulfilled.		
1.3. Expected learning outcomes		
1. Identify and interpret types of projects and the basis of construction regulations. 2. Interpret the components of a project and types of electrical schematics. 3. Identify and interpret the divisions of power plants and typical components. 4. Evaluate components of power plants according to rated voltage, rated current, installation location, operating conditions, etc. 5. Numerically evaluate and model basic electrotechnical calculations of low-voltage (LV) networks, middle (MV) networks and transformer substations (TS). 6. Evaluate the calculation results and apply them to the selection of components.		
1.4. Course content		
Types of projects by professions (architectural, construction, mechanical and electrotechnical) and by stages of implementation (conceptual, main, implementation, project of the completed state). Basic regulations in building sector. Simple buildings. Procedure for obtaining special conditions and obtaining a building permit. Constituent parts of the project: project terms of reference, technical description, budget, cost list, implementation of works in accordance with the rules of the electrical profession, the law on safe work and the law on fire protection in building sector, quality assurance related to the conformity of designed and installed products and testing after the work has been carried out, graphic attachments. Types of electrical schemes. Basic electrotechnical calculations of LV network, MV network and TS MV/LV transformer stations. Detailed price lists with the selection of components. Duties and role of the supervising engineer. Technical inspection and handover of the facility.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☐ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____

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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE)	1.5	1, 2, 3, 4, 5, 6	Lectures (L), auditory exercises (AE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Problem-solving exercises	1	5, 6	Control tasks - assignments (written exam)	Evaluation of solved tasks	25	50
Preparing for the oral exam and answering questions orally	1.5	1, 2, 3, 4, 6	Oral exam	Evaluation of the given theory answers	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. M. Stojkov, Z. Baus, M. Barukčić, I. Provči: Električni sklopni aparati, 2015.
2. N. Srb: Niskonaponske mreže i instalacije, 1991.
3. H. Požar: Visokonaponska rasklopna postrojenja, 1984.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. B. Lesan: Tehnički propisi i norme za transformatorske stanice 10(20)/0,4 kV, CIRED, 2010.
2. Catalogs of manufacturers of LV and MV installations and cables

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
M. Stojkov, Z. Baus, M. Barukčić, I. Provči: Električni sklopni aparati, 2015.	10	60
N. Srb: Niskonaponske mreže i instalacije, 1991.	10	60
H. Požar: Visokonaponska rasklopna postrojenja, 1984.	10	60

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting university questionnaires about teachers (availability at consultations, quality of teaching materials on course websites, clarity and comprehensibility of lectures, correctness of teachers in evaluation process) and conducting a faculty survey on learning outcomes and ECTS credits allocated to activities and courses as a whole).

General information		
Lead instructor(s)	Denis Pelin, PhD, Full Professor	
Course title	Standby Power Supply Systems	
Study programme	Graduate university study programme in Electrical Engineering, branches: Power Engineering and Industrial Automation	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+0+15+0+0

1. COURSE DESCRIPTION

1.1. Course objectives

Master the knowledge in the field of uninterruptible power supply systems, which creates the basis for understanding the operation, testing, commissioning and designing of the system.

1.2. Course enrolment requirements

Requirements for enrolment in the study programme fulfilled.

1.3. Expected learning outcomes

1. Classify the types of uninterruptible power supply systems (UPS).
2. Define the basic subsystems of an uninterruptible power supply with electronic power converters (UPS).
3. Choose the topological structure of the UPS.
4. Analyse UPS subsystems with regard to the type and method of connecting electronic energy converters.
5. Test and start up one selected UPS.

1.4. Course content

Basic terms. Division of uninterruptible power supply systems with regard to consumer types, switching time and autonomy. Types of uninterruptible power supply systems. Block motor-generator. Aggregates. Accumulator batteries. Uninterruptible power supplies with power electronic converters (UPS). Hybrid systems. Selection of the required power and topological structure of the UPS. Applicable guidelines, norms and regulations.

1.5. Types of classes	☒ lectures ☒ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance atlectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1	1, 2, 3, 4	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	7	10
Preparation for laboratory exercises (LE), results analysis, report writing	1	4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	25
Preparing for an oral exam and oral exam	1	1, 2, 3, 4	Oral exam	Evaluation	20	40
Creating a seminar paper and presenting student works	1	2, 4	Independent work	Evaluating a solution to a given problem	10	25

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. D.C. Griffith: Uninterruptuble power supplies, Marcel Dekker Inc., New York/Basel,1989.
2. A. Kusko: Emergency/standby power systems; McGraw Hii Book Comp., New York, 1989.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. I. Flegar: Elektronički energetski pretvarači, Kigen, Zagreb, 2010.
2. S. Skok: Besprekidni izvori napajanja, Kigen, Zagreb, 2002.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Elektronički energetski pretvarači	20	10

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Predrag Marić, PhD, Associate Professor	
Course title	Computing Methods and Software Support in Power Engineering	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Elective	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Adoption of computer methods and application of software tools in power engineering.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Classify computing methods in power engineering. 2. Create a flowchart of the algorithm and/or pseudocode of the computing method. 3. Model the components and operating states of the power system in the simulation interface. 4. Apply commercial simulation interfaces for calculations and simulations of characteristic variables in the power system. 5. Implement the computing method in the simulation interface.		
1.4. Course content		
Classification of computing methods in power engineering. Application of direct and iterative methods, basics of Monte Carlo simulations. Power system optimisation problem. Specification and application of optimisation methods: analytical methods, heuristic and meta-heuristic methods, artificial intelligence methods, methods based on biological and evolutionary principles, hybrid methods. Creating method code/pseudocode. Modelling components in the simulation interface for different operating states of the power system. Overview of commercial simulation interfaces. Calculation and analysis of load flows, short circuits, reliability, power quality, and power plant operation process in the simulation interface. Performing RMS and EMT simulations, quasi-dynamic simulations, modal analysis and protection coordination in the simulation interface. Connecting simulation interfaces, cosimulations. Application of commercial software tools in the design of lighting and low-voltage installations.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance atlectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1	1, 2, 3, 5	Lectures (L), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	1, 2, 3, 4	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	25	50
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 5	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Ahmed F. Zobaa, Shady H.E. Abdel Aleem and Almoataz Youssef, Classical and Recent Aspects of
2. Power System Optimization, Academic Press, Elsevier, 2018.
3. George Kusic, Computer-Aided Power Systems Analysis, CRC Press 2009
4. Reijer Idema, Domenico J.P. Lahaye, Computational Methods in Power System Analysis, Atlantis Press, 2014

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. PowerFactory 2022, User Manual, DIgSILENT GmbH, Germany, 2022
2. Simulink Documentation- MathWorks (https://www.mathworks.com/help/simulink/)
3. MATLAB Documentation – MathWorks (https://www.mathworks.com/help/matlab/)

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
J. Ahmed F. Zobaa, Shady H.E. Abdel Aleem and Almoataz Youssef, Classical and Recent Aspects of Power System Optimization, Academic Press, Elsevier, 2018	2	20
George Kusic, Computer-Aided Power Systems Analysis, CRC Press 2009	2	20
Reijer Idema, Domenico J.P. Lahaye, Computational Methods in PowerSystem Analysis, Atlantis Press, 2014	2	20

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Denis Pelin, PhD, Full Professor	
Course title	Applied Power Electronics	
Study programme	Graduate university study programme in Electrical Engineering, branches: Power Engineering and Industrial Automation	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+15+15+0+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Teach students about topologies of power electronic converters (PEC) for connecting systems of renewable energy sources to the grid and/or loads. Present to the students the modulation switching techniques of the PEC components with regard to optimisation according to the harmonic content of the current and/or voltage of the load, as well as the ways of controlling the PEC conversion components in order to reduce the grid load with reactive power. By mastering this knowledge, a basis is created for designing and testing industrial systems with PEC, as well as implementing protection against electromagnetic interference.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Identify PEC for connecting renewable energy sources to the grid and/or loads according to the frequency criterion. 2. Analyse the topologies of individual types of PEC for connecting renewable sources to the grid and/or consumer, considering the one-time nature of the conversion process. 3. Explain the concept of hysteresis control when applying a circuit for power factor correction, in order to reduce the feedback effect of the rectifier on the grid. 4. Calculate the conduction of converter switching components during bipolar and unipolar sine-pulse width modulation of the appropriate modulation depth and frequency ratio. 5. Sketch the waveforms of the output voltage, as well as the spectrum of the output voltage during bipolar and unipolar sine-pulse width modulation of the appropriate modulation depth and frequency ratio. 6. Evaluate pulse-width modulation techniques for controlling the converter components of the voltage converter for powering inductive consumers according to the harmonic content of the output voltage/current. 7. Apply spatial vector modulation to the control of a three-phase voltage converter with an inductive load. 8. Interpret the topologies and methods of multiple connection of PEC during the production of electrical energy from photovoltaic modules with regard to: connection of the converter, tracking the point of maximum power and galvanic isolation. 9. Categorise DC/DC converters for connection to fuel cells in order to achieve the required voltage levels in typical applications. 10. Analyse the ways of connecting wind turbines to the supply network, as well as the typical control subsystems of an electronic energy converter for wind turbines.		
1.4. Course content		
1.5. Types of classes	☒ lectures	☐ individual exercises

	☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☒ other team work
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.25	1, 2, 3, 6, 8, 9, 10	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	7	10
Problem-solving exercises	1	2, 4, 5, 6	Revision exams (written exam)	Evaluation	10	20
Preparation for laboratory exercises (LE), results analysis, report writing	1	2, 3, 7, 8, 9	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	12	24
Converter topologies recognition checks	0.5	3, 4	Team work	Evaluating a solution to a given problem	7	16
Preparing for an oral exam and oral exam	1.25	1, 2, 3, 6, 8, 9, 10	Oral exam	Evaluation	15	30

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. I. Flegar Elektronički energetski pretvarači
2. J.G. Kassakian, M.F.Schlecht, G.C.Verghese Osnove energetske elektronike-I dio; Topologije i funkcije pretvarača
3. Ambrožič, V, Zajec, P. Električni servo pogoni

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. B.Bose: Power Electronic and Variable Frequency Drives:Technology and Applications

2. S. Sumathi, L. Ashok Kumar, P. Surekha: Solar PV and Wind Energy Conversion Systems

3. R. Teodorescu, M. Liserre, P. Rodriguez: Grid converters for photovoltaic and wind power systems

4. A. Emadi: Handbook of Automotive Power Electronics and motor drives
1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Elektronički energetski pretvarači	20	30
Električni servo pogoni	10	30
Osnove energetske elektronike-I dio; Topologije i funkcije pretvarača	2	30

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Danijel Topić, PhD, Associate Professor	
Course title	Energy Storage and Electric Vehicles in Power Systems	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+15+0)+0

1. COURSE DESCRIPTION

1.1. Course objectives

Educate students about the types of electric vehicles and their impact on power systems. Teach students about the types of energy storage systems and their application in power systems.

1.2. Course enrolment requirements

Requirements for enrolment in the study programme fulfilled.

1.3. Expected learning outcomes

6. Evaluate the advantages and disadvantages of different energy storage technologies in the transmission network.
7. Calculate the economic feasibility of investing in energy storage systems in the power system.
8. Identify the systems and components of electric vehicles.
9. Calculate the required power and energy for operating an electric vehicle.
10. Analyse the impact of electric vehicles on the power grid.
11. Analyse the environmental impact of electric vehicles.

1.4. Course content

Overview and classification of energy storage systems. Mechanical, electrical, chemical, electrochemical, and thermal energy storage systems. Technical characteristics of energy storage systems. Efficiency of energy storage systems. Modelling and sizing of energy storage systems. Classification of electric and hybrid vehicles. Overview of the share of hybrid and electric vehicles and their future in the European Union and Croatia. Incentives for hybrid and electric vehicles. Impact of electric vehicles on greenhouse gas emissions. Issues related to battery production, battery lifespan, and recycling. Charging of electric vehicles. Requirements for the distribution power grid. Range, consumption, and efficiency.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☒ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE)	2	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	10
Problem-solving exercises	1	2, 4, 5	Revision exams (written exam)	Evaluation	15	30
Preparation for laboratory exercises (LE), results analysis, report writing	0.5	2, 5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	0	10
Preparing for an oral exam and oral exam	1	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

Trevor M. Letcher, Storing Energy, 2016.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Trevor M. Letcher, Storing Energy, 2016.	1	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Predrag Marić, PhD, Associate Professor, Srete Nikolovski, PhD, Full Professor	
Course title	Power System Protection	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+15+0)+0

1. COURSE DESCRIPTION

1.1. Course objectives

To teach students for independent selection and design and calculations and coordination of overcurrent, over/under voltage, over/under frequency, differential and distance protection of generators, transformers, motors, overhead lines and cables and lines and power system as a whole.

1.2. Course enrolment requirements

Requirements for enrolment in the study programme fulfilled.

1.3. Expected learning outcomes

1. Understand the role and types of protections and their task in power system.
2. Understand the basic operating principles of current, voltage, power and frequency relays.
3. Analyse and simulate using simulation tools the modes of operation, settings and coordination of overcurrent and of remote relays for protection in EES.
4. Evaluate the features of different types and performance of digital protection of generators, transformers, buses and lines.
5. Create models and tune overcurrent, voltage and frequency protections and evaluate features of their operation.
6. Using test-measuring devices, evaluate the correct operation of protective devices.

1.4. Course content

The basic task of protection, operating principles and features of power system protection. Basic requirements before power system protection installation. Principles of operation of electromechanical, static and digital relays, current, differential, voltage, frequency, thermal and power relays. Overcurrent relays with time-independent and dependent current characteristics. Voltage, frequency and power relays. Selection of protective relays according to the type of protected component. Time currents- t-I characteristics of individual relays. Malfunctions and impermissible states of the generator. Stator short-circuit protection. Stator earth-fault protection. Protection against the connection of turns of the same phase. Rotor earth- fault protection. Overload protection. Overvoltage protection. Return power protection (motor operation). Protection against asynchronous operation. Overspeed protection. Generator overheating protection. Criteria for choosing generator protection. Malfunctions and impermissibility states of the transformer. Principles and methods of transformer protection. Differential protection. Gas protection (Buholtz). Earth fault protection. Instantaneous overcurrent protection. Overload protection of transformer (thermal protection). Transformer protection against short-circuit currents in the network. Protection from overloading of the transformer core. Control switch protection. Malfunctions and dangerous operating conditions in power grids. Overcurrent and directional phase protection of lines. Earth- fault and directional earth- fault protection of the lines. Remote protection. Differential protection with pilot conductors. Bus protection. Engine protection.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 4, 5	Lectures (L), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	5	10
Problem-solving exercises	1	3, 4, 5	Revision exams (written exam)	Evaluation	10	20
Preparation for laboratory exercises (LE), results analysis, report writing	1	3, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Preparing for an oral exam and oral exam	2	1-6	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Srete Nikolovski: Zaštita u EES-u udžbenik, ETF , Osijek 2007

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Paul Anderson, Power system protection, IEEE Press. 1998

2. ABB, SIEMENS Končar katalozi

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*

Srete Nikolovski: Zaštita u EES-u udžbenik, ETF, Osijek 2007	40	45
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Hrvoje Glavaš, PhD, Associate Professor	
Course title	Power System Operation Control	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To make students familiar with the basics of regulation in the electric power system, with the basics of power system control, as well as with the possibilities of meeting the needs of consumers for power and energy.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Evaluate and classify control in the power system. 2. Evaluate the remote control system within the power system. 3. Evaluate the processes of frequency and active power regulation and voltage and reactive power regulation of the electric power system. 4. Evaluate the power and voltage regulation of the power plant during parallel operation with the power system. 5. Rank and compare the types of stability in the Power System, select the most important parameters that determine the dynamic management of the Power System, distinguishing the operation of the Power System in interconnection with other Power System from the island operation of an individual Power System. 6. Critically judge the aspects of power system management and management by applying appropriate software tools. 7. Rank and choose methods for defending the power system against disturbances. 8. Propose and evaluate a monitoring system based on synchronized phasor measurements (WAM) in the function of power system management.		
1.4. Course content		
Basic physical laws of power system operation. Regulation of the active power and voltage of the power plant when working on its own network. Regulation of active and reactive power of power plants during parallel operation with the system. Regulation of active power and frequency of Power System. Higher level cooperation between power systems. Coordinated voltage regulation in the power system. Management in power system. Communication and network protocols. Data collection from a real system. Application programs. SCADA system. Functions and structure of remote control centers. Dispatch centers for managing transmission network operations. Structure and tasks of program support in national dispatch centers. Programs for on-line analysis of power networks. Programs for off-line analysis of power networks (power flows, voltage plan. Dispatch centers for managing network operations. DMS system functions. Remote control centers in industrial plants. Program support for managing industrial networks. Intelligent alarm processing in the power system. Meeting the needs of energy and power in the power system.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops	☐ individual exercises ☐ multimedia and network

	☒ auditory exercises ☒ distance learning ☐ field work	☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.5	1, 2, 3, 4, 5, 6, 7, 8	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	10	20
Problem-solving exercises	1	2, 3, 4,	Revision exams (written exam)	Evaluation	10	20
Preparation for laboratory exercises (LE), results analysis, report writing	1	2, 3, 4,	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	0	20
Preparing for an oral exam and oral exam	2.5	1, 2, 3, 4, 5, 6, 7, 8	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. L. Jozsa: Vođenje pogona elektroenergetskog sustava, skripta, ETF Osijek, 2005.
2. P. Kundur: Power System Stability and Control, McGraw-Hill, 1994.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. P. S. R. Murty: Operation and Control in Power Systems, BS Publishers Hyderabad, 2008.
2. M. Zima, M. Bočkarjova: Operation, Monitoring and Control Technology of Power Systems, ETH Zürich, 2007.
3. I. Fagarasan, S. St. Iliescu, N. Arghira, Advances in Power System Control, Proceedings of the 1st Workshop on Energy, Transport and Environmental Control Applications, pp 62-71 ISBN 978-973-618-218-1, Targoviste, 2009.
4. Modern Power System Control and Operation; A. S. DEBS; DSI; 1988; ISBN: ISBN-13 978-0898382655

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*

L. Jozsa: Vođenje pogona elektroenergetskog sustava, skripta, ETF Osijek, 2005.	15	45
P. Kundur: Power System Stability and Control, McGraw-Hill, 1994.	1	45
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Zvonimir Klaić, PhD, Associate Professor	
Course title	Smart Power Grids	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(0+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To introduce students to the basic concept, parts, design, technologies and ways of running smart grids. To introduce students with the basic concept and design of microgrids, with components and management methods and strategies. To introduce students to the following terms: smart cities and islands, load management, smart house, virtual power plants.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Explain the basic concept, parts, design, technologies, hierarchical levels, structure and management methods of smart grids and compare smart grids to conventional power networks, 2. Compare measurement and data collection systems in smart grid. 3. Explain the basic concept and design of microgrids, describe the components and interpret methods and strategies of microgrid management 4. Explain the concepts of smart cities and islands. 5. Explain the terms load management, smart house, virtual power plants. 6. Determine the current and voltage conditions in smart transmission and distribution networks and microgrids.		
1.4. Course content		
Concept, design and parts of smart grids. Technologies, hierarchical levels, structure and ways of managing smart grids. The basic concept and design of microgrids, components and microgrid management methods and strategies. Load management. Comparison of advanced networks and microgrids to conventional networks. Smart houses. Virtual power plants.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	0.5	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	7	10
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	30
Preparing for an oral exam and oral exam	3	1, 2, 3, 4, 5	Oral exam	Evaluation	30	60

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. James Momoh: Smart Grid Fundamentals of Design and Analysis, John Wiley & Sons, 2012.
2. Nikos Hadziargyriou Microgrids, Arhitectures and Control, John Wiley & Sons, 2014.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Janaka B. Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama: Smart Grid: Technology and Applications, John Wiley & Sons, 2012.

2. Radian Belu: Smart Grid Fundamentals Energy Generation, Transmission and Distribution, CRC Press, 2022.

3. Mini S. Thomas, John D. McDonald: Power System SCADA and Smart Grids, CRC Press, 2015.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
1. James Momoh: SMART GRID Fundamentals of Design and Analysis, John Wiley & Sons, 2012.	1	45
2. Nikos Hadziargyriou Microgrids, Arhitectures and Control, John Wiley & Sons, 2014.	1	45

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Dominika Crnjac Milić, Full Professor	
Course title	Project Management	
Study programme	Graduate university study programme in Electrical Engineering, all branches (Power Engineering, Industrial Automation and Communications and Informatics)	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+0+0+0)

1. COURSE DESCRIPTION

1.1. Course objectives

To teach students about project management as a management process in which knowledge, skills, tools and techniques are applied to project activities in order to meet the requirements and needs of projects, but also to fulfil the strategic goals of a business organisation. The goal is to encourage students to work in teams in such a way that, with the mentoring of the teacher, they jointly elaborate on the content of the assigned project and its main goals. We aim to teach them about the identification of the main activities on the project and about the work breakdown structure (WBS). The students will be given directions related to the time planning of each individual activity and determine the critical points and paths that could be used to solve the obstacles on the way to realisation. The goal is to give them directions related to capacity planning, bottleneck detection and capacity balancing as well as provide knowledge related to cost determination, project profitability calculation and risk analysis.
Through the course, students will be taught about all phases of project planning, implementation and management.

1.2. Course enrolment requirements

Requirements for enrolment in the second year of study fulfilled.

1.3. Expected learning outcomes

1. Specify, explain basic management functions, define and explain enterprise management through projects.
2. Specify and describe the basic managers skills important for high quality managing projects.
3. Explain the strategic dimension of project management.
4. Explain the operational dimension of project management, analyse the phases of the project, develop the premises of the business plan for a specific project, select and formulate the main objectives of the project and rank them.
5. Develop and evaluate the main activities of the project and the work breakdown structure (WBS - Work Breakdown Structure), analyse the totality of project tasks, and design the project budget as an example.
   Implement your own solution to the proposed project task (assess the capacities needed for project realisation/determine bottlenecks, balance activities, determine costs and risks; make time plan for the realisation of individual project tasks and identify their mutual relationships addiction; apply project management methods and techniques in the planning and implementation of specific projects from the field of study in a team environment; document all phases of project management in accordance with applicable standards; apply appropriate software solutions for project management).

1.4. Course content

Projects and project-oriented business (concept and essential characteristics of a project; basic distinction of projects; project life cycle; project-oriented business); concept and context of project management;

development strategy of project management (phases of project management development; project management through strategic development of project business); design of an organisation for project management (design of an organisation for the management of one-off projects; organisational design for the management of project processes; organisation and development of the project management system); strategic dimension of project management (initiation and activation of project implementation; planning and organisation of project implementation logistics; evaluation and completion of project implementation); operational dimension of project management (management of project integration; management of project organisation; management of implementation of the system of primary project objectives; project management control and management of project changes; development perspectives of project management).

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☐ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance atlectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	0.0	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Answering theoretical questions	2.0	1, 2, 3, 4, 5, 6	Revision exams (written exam)	Evaluation	30	60
Oral presentation of project proposals with the help of prepared project documentation and ppt presentation	0.5	4, 5, 6	Oral presentation	Evaluation	5	10
Creation of project proposal documentation	0.5	4, 5, 6	Under the mentorship of the professor, students create documentation for a	In accordance with the given instructions for creating the documentation of the project	5	10

			given project proposal	proposal, the professor checks what has been written		
Creation of a ppt presentation and presentation of the topic of the seminar paper	0.5	4, 5, 6	According to the professor's instructions, students prepare the content of the presentation on the given topic of the seminar paper, while following the content of the previously written of work. Teamwork.	After listening to the presentation of the topic of the seminar work with the help of a ppt presentation, the professor awards points for a successfully completed activity.	5	10
Creating a seminar paper	0.5	4, 5, 6	Studying the literature related to the given topic of the seminar paper and writing the seminar paper. Teamwork.	According to the instructions for writing the seminar paper, the content and written expression of the written form are evaluated.	5	10

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Project management, Mislav Ante Omazić, Stipe Baljkas, Sinergija, Zagreb, 2005.
2. Project Management Knowledge Guide (PMBOK Guide) - Fourth Edition, Project Management Institute, Global Standard, Mate d.o.o., Zagreb,2011.
3. Project management, Vlado Majstorović, Sveučilište u Mostaru, Mostar, 2010.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1.A guide to project management from start to the end, Gregory M. Horine, DVA I DVA, Zagreb, 2009.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Project management	1	110
Project Management Knowledge Guide (PMBOK Guide) - Fourth Edition	1	110
Project management	15	110
A Guide to Project Management from Start to the end	1	110

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Goran Knežević, PhD, Associate Professor	
Course title	Switching Devices and High-Voltage Technology	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+15+15+0+0

1. COURSE DESCRIPTION
1.1. Course objectives
Train students to define and recognise specific problems related to the construction and selection of high-voltage components. Explain to the students the determination of the characteristics of switching devices and their correct selection for a specific installation location in the power system while meeting the necessary current and voltage conditions.
1.2. Course enrolment requirements
Requirements for enrolment in the second year of study fulfilled.
1.3. Expected learning outcomes
1. Determine the parameters necessary for the selection of switchgear and protective devices. 2. Determine the elements of the power system that are used in the transmission of electricity at high voltage. 3. Determine the method of production and measurement of high voltage. 4. Choose the procedure for testing the insulation properties of high-voltage devices and equipment in the high-voltage test laboratory. 5. Determine the types of overvoltage that occur in the power system. 6. Determine the causes of switching overvoltages in the power system. 7. Evaluate the coordination of high-voltage power substation insulation. 8. Determine nominal and test voltages for individual voltage levels. 9. Determine insulation systems in high-voltage systems. 10. Analyse characteristic atmospheric overvoltages in the power system. 11. Select the technical data of the surge arrester. 12. Analyse overvoltages in the power system using appropriate software tools. 13. Analyse the results of the calculation of short-circuit currents in order to correctly select the switchgear at the observed location in the power substation
1.4. Course content
Electric field. Gas dielectrics. Breakdown in a homogeneous field. Breakdown in a gas in an inhomogeneous electric field. Rigid dielectrics. Liquid dielectrics. Surge voltage. Surge classification. Switching overvoltages. Atmospheric surges. Principles of insulation coordination. Traveling waves. Modelling of elements for surge calculation. Tests in high voltage technique, breakdown in dielectrics. Production and measurement of high direct and alternating voltage in the high voltage laboratory. Traveling waves, surges and surge protection. Surge analysis using software tools. Live line work. Electrical contacts and energy theories of the electric arc. Contact resistance, tensile and layer resistance. Properties of contact materials and thermal stress of contacts. Types, characteristics and construction of switching devices. Division and function of switching devices (switches, current breakers, contactors, cam switches, isolating switches, disconnectors, earthing switches,

fuses, surge arresters, devices for control and auxiliary circuits). Testing, maintenance, selection and design of switchgear.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance atlectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1	1, 2, 3, 5, 6, 7, 8, 9, 10, 11	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Problem-solving exercises	1	7, 8, 11, 13	Revision exams (written exam)	Evaluation	20	40
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	4, 6, 7, 12	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	5	10
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 5, 6, 8, 9, 10	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. M. Stojkov, Z. Baus, M. Barukčič, I. Provči, Električni sklopni aparati, Slavonski Brod / Osijek : Strojarski fakultet u Slavonskom Brodu, 2015 (textbook).
2. M. Barukčić, Z. Baus, Osnove električnih sklopnih aparata (a collection of problems with numerical solutions in MATHCAD), FERIT Osijek, 2010.
3. H. Požar, Visokonaponska rasklopna postrojenja, Tehnička knjiga - Zagreb, 1967.
4. I. Uglešić, Tehnika visokog napona, FER, Zagreb, 2002.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. J. Kuffel, P. Kuffel, E. Kuffel, W. Ziomek , High Voltage Engineering fundamentals, Elsevier, 2016.
2. C.L. Wadhwa, High voltage engineering, New Age International, 2007.

3. Mazel Abdel-Salam, High-Voltage Engineering , CRC Press, 2019.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
M. Stojkov, Z. Baus, M. Barukčič, I. Provči, Električni sklopni aparati, Slavonski Brod / Osijek : Strojarski fakultet u Slavonskom Brodu, 2015 (textbook).	3	25
M. Barukčić, Z. Baus, Osnove električnih sklopnih aparata - a collection of problems with numerical solutions in MATHCAD), FERIT Osijek, 2010.	2	25
H. Požar, Visokonaponska rasklopna postrojenja, Tehnička knjiga - Zagreb, 1967.	3	25
I. Uglešić, Tehnika visokog napona, FER, Zagreb, 2002.	2	25

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Goran Knežević, PhD, Associate Professor	
Course title	Grounding Devices and Grounding Systems	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+0+15+15+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Explain to students the dimensioning of the grounding system of an electric power substation. Train students to independently calculate and measure the grounding resistance of an electric power substation.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Define the basic concepts of grounding device and grounding system. 2. Categorise the types of grounding devices. 3. Calculate the grounding resistance of simple grounding systems. 4. Construct assembled grounding devices by combining groups of lines and rods. 5. Evaluate the results of grounding resistance calculations of rod, line, foundation and mesh grounding devices 6. Calculate the distribution of the fault current in the grounding system. 7. Measure the grounding resistance of high-voltage power substation. 8. Design a complex grounding system of a power substation using software. 9. Apply methods to reduce touch and step voltages.		
1.4. Course content		
Types of grounding, defining the terms of grounding device and grounding system. Soil characteristics, seasonal changes in soil resistance, measurements of soil resistance. Touch voltage, step voltage and electric shock protection criteria. Theoretical settings for the calculation of earthing resistance, the basics of numerical methods for the analysis of the earthing system. Vertically buried grounding devices, potential distribution and determination of grounding resistance of rod earthing device. Line grounding device, distribution of potential and determination of grounding resistance. Foundation grounding device, reinforced foundations as foundation grounding devices. Combined grounding device made with groups of rod and line grounding devices, ray grounding devices, ring grounding devices, mesh grounding devices. Grounding devices for protection against atmospheric discharges (impulse earthing devices). Grounding reduction factor, application of the metal jacket of the cable as a grounding device, problems of potential exposure. Special grounding devices. Grounding of the substation fence. Designing and execution of substation grounding devices and transmission line poles. Calculation of grounding resistance and potential distribution using a software package for different grounding device configurations.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises

	☐ auditory exercises ☒ distance learning ☐ field work	☒ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work		
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 student work during classes and in the final exam		

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1	1, 2, 3, 5, 9	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Solving the project task	1	5, 8, 9	Design exercises (DE)	Evaluation of solutions for a given problem	15	30
Preparation for laboratory exercises (LE), results analysis, report writing	1	4, 5, 6, 7, 8	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Preparing for an oral exam and oral exam	1	1, 2, 3, 5, 9	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. F. Majdandžić, Uzemljivači i sustavi uzemljenja, Graphis, Zagreb, 2004.
2. H. Požar, Visokonaponska rasklopna postrojenja, Tehnička knjiga - Zagreb, 1967.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. A.P. Sakis Meliopulos, Power System Grounding and Transients: An Introduction, Marcel Dekker, Inc., New York, 1988.
2. M. Padelin, Zaštita od groma, Školska knjiga, Zagreb 1987.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
F. Majdandžić, Uzemljivači i sustavi uzemljenja, Graphis, Zagreb, 2004.	1	12
H. Požar, Visokonaponska rasklopna postrojenja, Tehnička knjiga - Zagreb, 1967.	1	12

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Danijel Topić, PhD, Associate Professor	
Course title	Thermal Applications of Renewable Energy Sources	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+0+15)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To introduce students to technologies for generating thermal energy from renewable sources, including cogeneration and trigeneration systems.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. List the types of renewable energy sources that can be used for thermal energy production. 2. Classify and list the types of renewable energy sources that can be used for cogeneration and trigeneration. 3. Explain the application of specific types of renewable energy sources for thermal applications. 4. Calculate the expected thermal energy output for various thermal applications of renewable energy sources.		
1.4. Course content		
Classification of energy sources. Types of renewable energy sources. Biomass heating. Micro cogeneration and trigeneration systems in buildings. Geothermal energy. Heat pumps. Conversion of solar radiation into thermal energy for domestic hot water preparation and space heating. Solar cooling. Solar thermal power plants.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☒ individual exercises ☐ multimedia and network ☐ laboratory exercises ☒ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work		

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), design exercises (DE)	2	1, 2, 3, 4	Lectures (L), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	10
Independent solving of the assigned problem	1	1, 2, 3, 4	Design exercises (DE)	Evaluation of the solved problem	20	40
Preparing for an oral exam and oral exam	1	1, 2, 3, 4	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Gerhard Stryi-Hipp Renewable Heating and Cooling: Technologies and Application, Woodhead, Publishing, 2016.
2. Andriy Redko, Oleksandr Redko, Ronald DiPippo, Low-Temperature Energy Systems with Applications of Renewable Energy, Academic Press, 2020.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Nicolae Badea Design for Micro-Combined Cooling, Heating and Power Systems: Stirling Engines and Renewable Power Systems

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Gerhard Stryi-Hipp Renewable Heating and Cooling: Technologies and Application, Woodhead, Publishing, 2016.	2	10
Andriy Redko, Oleksandr Redko, Ronald DiPippo, Low-Temperature Energy Systems with Applications of Renewable Energy, Academic Press, 2020.	2	10

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information

Lead instructor(s)	Krešimir Fekete, PhD, Associate Professor
Course title	Power System Planning
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering
Course status	Elective
Year of study	2

ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+0+15+0+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
The objective of the course is to train students to independently define and solve optimisation problems in short-term planning of power system operation in electricity market conditions.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Determine the basic terms of short-term power system planning. 2. Interpret the following optimisation problems: economic dispatch, optimal power flows, hydropower unit commitment, thermal power unit commitment, and hybrid hydro-thermal unit commitment. 3. Perform economic dispatch and optimal power flows using test power system models by software. 4. Create optimisation procedures for hydro and thermal power plant unit commitment in electricity market conditions using software. 5. Define the objective function and related constraints of the optimisation problem of cascaded hydropower plants operation. 6. Define the objective function and related constraints of the optimisation problem of cascaded hydropower plants and wind power plants coordinate operation while respecting the limitations of the transmission network 7. Review the influence of renewable energy sources on the power system operation planning.		
1.4. Course content		
Introduction - the structure of the power system, basic concepts of short-term power system operation planning, the structure of the electricity market and trading principles, load forecast, and overview of optimisation methods implemented in the energy management system (EMS system): Economic Dispatch, Optimal Power Flow, Thermal Unit Commitment and Hydro Unit Commitment. Hybrid Unit Commitment - optimization model of short-term planning of a hybrid system that can consist of different types of hydroelectric power plants, thermal power plants, and wind power plants. The impact of renewable energy on the power system planning.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☒ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work		
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 student work during classes and in the final exam		

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), laboratory exercises (LE), design exercises (DE)	1	1, 2, 3, 4, 5, 6 ,7	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Preparation for laboratory exercises (LE), results analysis, report writing	1	3, 4, 7	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	0	20
Preparing for an oral exam and oral exam	1	1, 2, 4, 5, 6, 7	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. A.J. Momoh Electric Power System Applications of Optimization
2. Lukač Z; Neralić L. Operacijska istraživanja

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. A.J. Wood, B.F. Wollenberg Power Generation Operation and Control
2. M. Shahidehpour, H. Yaminand Z. Li Market Operationsin Electric Power System – Forecasting, Scheduling and Risk Management
3. D.S. Kirschen, G. Strbac Fundamentals of Power System Economics
4. S. Nikolovski, K. Fekete, G. Knežević, Z. Stanić Uvod u tržište električne energije
5. L. Söder, M. Amelin Efficient Operation and Planning of Power System, 8th ed.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
A.J. Momoh Electric Power System Applications of Optimization	1	10
Lukač Z; Neralić L. Operacijska istraživanja	1	10

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Kruno Miličević, PhD, Full Professor	
Course title	Electrical and Industrial Measurements	
Study programme	Graduate university study programme in Electrical Engineering, branches: Power Engineering and Industrial Automation	
Course status	Elective – branch: Power Engineering Compulsory – branch: Industrial Automation	
Year of study	2 (Power Engineering) 1 (Industrial Automation)	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(0+30+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Introduce students to the skills of accurate measurement of electrical quantities, the specifics of process signals, and measurements in an industrial environment, techniques for converting process variables into electrical signals to enhance understanding of measurement procedures as part of automated processes. Present students with options for selecting measuring transducers and process measuring instruments, considering not only accuracy, reliability, and cost requirements but also maintenance and calibration needs.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study in Power Engineering fulfilled. Requirements for enrolment in the study programme in Industrial Automation fulfilled.		
1.3. Expected learning outcomes		
1. Recognise the specifics of measurement quantities in industry. 2. Define measurement methods and equipment for electrical and industrial measurements according to the specifics of the industrial plant. 3. Classify measurement sensors by type and design. 4. Identify interferences that occur in an industrial environment and take measures to reduce them to an acceptable level. 5. Select the type and characteristics of measurement sensors and measuring devices for a specific process measurement task. 6. Conduct power quality measurements in industrial plants.		
1.4. Course content		
Measurement sources and meters for electrical quantities, measurement methods specific to industrial systems. Standard measurement signals. Application of communication protocols in metrology. Interference, noise, and their reduction. Selection of the most suitable meter for a specific purpose. Measurement of power quality. Adaptation of electrical quantities and measurement signals in industrial systems (unbalanced measurement bridges, measuring amplifiers, measuring transformers and dividers, etc.). Active and passive sensors. Piezoelectric, thermodynamic, photoelectric, chemical, optical, inductive, capacitive, magnetic sensors, and similar. Mechanical limit switches, encoders, resolvers, force and torque sensors, compass, accelerometer, gyroscope, and similar. Process instrumentation and process analytics. Measurement procedures and sensors for measuring pressure, level, flow, temperature, humidity, etc. Measurement procedures and systems for gas and liquid analysis.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises

	☐ distance learning ☐ field work	☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2.5	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Preparation for laboratory exercises (LE), results analysis, report writing	2.5	1, 2, 4, 5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	25	50
Preparing for an oral exam and oral exam	2	1, 2, 3, 5, 6	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Valter, Z. Procesna mjerenja, Elektrotehnički fakultet Osijek, 2008
2. Morris A.S; Langari R. Measurement and Instrumentation-Theory and Application, Academic Press, 2020

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. V. Bego Mjerenja u elektrotehnici
2. R. Malarić Instrumentation and measurement in electrical engineering
3. Z. Godec, D. Dorić Osnove mjerenja, laboratorijske vježbe / 5. izd
4. A. Šantić Elektronička instrumentacija
5. Thomas Stauss Flow Handbook, 3rd Edition
6. Donald R. Gillum Industrial Pressure, Level and Density Measurement 2nd edition, ISA – Instrumentation
7. Omega Transactions in Measurement and Control: Volume 2 Data Acquisition
8. Omega Transactions in Measurement and Control: Volume 3 Pressure
9. Omega Transactions in Measurement and Control: Volume 4 Flow and Level

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Valter, Z. Procesna mjerenja, Elektrotehnički fakultet Osijek, 2008	2	15

Morris A.S; Langari R. Measurement and Instrumentation-Theory and Application, Academic Press, 2020	2	15
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Marinko Barukčić, PhD, Associate Professor	
Course title	Real-Time Simulations of Electrical Engineering Systems	
Study programme	Graduate university study programme in Electrical Engineering, branches: Power Engineering and Industrial Automation	
Course status	Compulsory – branch: Industrial Automation Elective – branch: Power Engineering	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(0+45+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To provide students with the competencies necessary for conducting real-time simulations of electrical engineering systems, as well as interpreting and utilising the results of these simulations to enhance the functionality of real electrical engineering systems.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Understand mathematical models of electrotechnical systems. 2. Develop simulation models of electrotechnical systems. 3. Understand simulation methods of electrotechnical systems and concepts of real-time simulations. 4. Learn how to operate real-time simulation systems. 5. Analyse the operation of real-time simulation systems and simulation results. 6. Develop a simple digital twin system.		
1.4. Course content		
• Mathematical modelling analysis of electrotechnical systems. • Development of simulation models for electrotechnical systems. • Introduction to basic numerical methods for solving transient discrete system models. • Concept of steady-state and quasi-steady-state conditions and models. • Simulation of electropower systems in steady-state, quasi-steady-state, and transient states. • Introduction to the concept of real-time simulation. • Introduction to x-in-the-loop (x-IL) systems. • Familiarisation with real-time simulation simulators: construction, functionality, device operation. • Conducting real-time simulations. • Real-time and post-processing of simulated data. • Concept of applying x-IL systems – Rapid prototyping of control circuits. • Concept of applying x-IL systems – Testing control system operation using HIL approach. • Concept of applying x-IL systems – Optimisation of power grid operation using SIL approach. • Concept of applying x-IL systems – Automated product testing in development phases using x-IL approach. • Concept of digital twinning. • Emulation of electrotechnical systems (P-HIL). • Digital twinning as part of a real system.		
1.5. Types of classes	☒ lectures	☒ individual exercises

	☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.6	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Preparation for laboratory exercises (LE), results analysis, report writing	2.4	4, 5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	25	50
Preparing for an oral exam and oral exam	1	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

[V. Dinavahi i N. Lin, Real-Time Electromagnetic Transient Simulation of AC-DC Networks, Wiley-IEEE Press, 2021.
K. Popovici i P. J. Mosterman, Ur., Real-Time Simulation Technologies: Principles, Methodologies, and Applications, Taylor & Francis Ltd., 2017.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

J. Ukko, M. Saunila, J. Heikkinen, R. S. Semken i A. Mikkola, Ur., Real-time simulation for sustainable production : enhancing user experience and creating business value, Abingdon, Oxon New York, NY: Routledge, 2021.
A. L. Kumar, V. Indragandhi i U. Y. Maheswari, Software Tools for the Simulation of Electrical Systems, Elsevier Science Publishing Co Inc, 2020.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*

V. Dinavahi and N. Lin, Real-Time Electromagnetic Transient Simulation of AC-DC Networks, Wiley-IEEE Press, 2021.	2	15
K. Popovici and P. J. Mosterman, Ur., Real-Time Simulation Technologies: Principles, Methodologies, and Applications, Taylor & Francis Ltd., 2017.	2	15
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Željko Hederić, PhD, Full Professor, Marinko Barukčić, PhD, Associate Professor	
Course title	Electric Machines	
Study programme	Graduate university study programme in Electrical Engineering, branch: Industrial Automation	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + (auditory exercises + laboratory exercises + design exercises) + seminars)	30+(15+0+30)+0

1. COURSE DESCRIPTION

1.1. Course objectives

Introduce students with the functional principles of electrical machines, components and operating conditions. Introduction to the basics of analysing the operation of individual electrical machines in different operating modes. Introduction to the basics of procedures for diagnosing the condition and monitoring the operation of electrical machines in systems. To enable trainees to carry out simple calculations and analyses of voltages, currents, power and efficiencies for various loads of asynchronous, direct current and synchronous machines. Training in the implementation of measurement and test procedures for asynchronous and direct current motors, synchronous and direct current generators as well as in the analysis and calculation of all variables obtained from these measurements. Training in the numerical calculations of electromagnetic fields with the aid of computer programmes for the simulation of electromagnetic fields.

1.2. Course enrolment requirements

Requirements for enrolment in the first year of study fulfilled.

1.3. Expected learning outcomes

1. Know the functional principle, the components, the role of the transformer in the power grid and the basic operating states of the transformer (open circuit, short circuit, load).
2.Understand the functional principle, the structural parts, the role of direct current, asynchronous and synchronous machines in drives and the basic operating states (open circuit, short circuit, load).
3. Assess the procedures for diagnosing the condition and the results of monitoring the operation of electrical machines in systems.
4. Explain the calculated values for voltages, currents, power and efficiency for various loads of asynchronous, direct current and synchronous machines.
5. Critically analyse the solutions obtained for selected numerical examples of electrical machines.
6. Categorise and differentiate between the measurement and test methods of asynchronous and direct current motors, synchronous and direct current generators and explain and analyse the calculated values obtained from these measurements.

1.4. Course content

Magnetic systems. Transformers. Basic principles of electrical machines. Synchronous machines. Synchronous machine in a rigid network. An instantaneous property. Synchronous machine on its own network. Synchronous motor. Performance and characteristics. Asynchronous machines. An instantaneous property. Disc motor. Squirrel cage. Rotor with current suppression. Designs and types of protection. Direct current machines. Types of excitation. The reaction of the amplification. Generator and motor characteristics. Regulation of voltage and speed. Switching. Labelling and winding design. Single-phase machines. Single-phase asynchronous and synchronous motors. A universal motor. Special types of machines. Linear motors. Stepper motors. Introduction to numerical field calculations. Basics of the finite element method.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Solving tasks	0.5	1, 2, 3, 4, 5	Control tasks (written exam)	Checking solved tasks	5	10
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	2, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	30
Preparing for an oral exam and oral exam	2	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	30	60

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Pužar, M; Mandić, I. Basics of Electrical Machines. Osijek, 2010.

2. Fitzgerald, E. C; Kingsley; S. D. Umans. Electric Machinery. McGraw-Hill, 2012.

3. Wolf, R., Fundamentals of Electrical Machines, Školska knjiga, Zagreb 1991

4. Ulaby Fawwaz; Michielssen Eric; Ravaioli Umberto. Fundamentals of Applied Electromagnetics. Prentice Hall, 2010.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Piotrovskij, L.M., Electric Machines, Technical Book, Zagreb 1970.

2. Knapp Vladimir; Colić Petar: Introduction to el. and magn. properties of materials, Zagreb Školska knjiga 1990

3. Sirotić, Z., Maljković, Z., Synchronous Machines, Script ETF Zagreb, 1996.

4. Mandić, Tomljenović, Pužar: Synchronous and Asynchronous Electrical Machines, Polytechnic Zagreb 2012

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Pužar, M; Mandić, I. Basics of Electrical Machines	2	15
Wolf, R., Fundamentals of Electrical Machines	2	15
Fitzgerald, E. C; Kingsley; S. D. Umans. Electric Machinery	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Srete Nikolovski, PhD, Full Professor, Predrag Marić, PhD, Associate Professor	
Course title	Protection Coordination of Active Power Grids	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Train students to independently model, simulate, design and coordinate the protection of all types of power grids with the presence of distributed generation.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Describe and understand grounding methods in active grids with the presence of distributed sources. 2. Analyse the issue of anti-islanding protection of distributed sources through passive, active and hybrid detection methods. 3. Create a grid model and protective devices of current phase and earth fault protection in grids with distributed sources. 4. Evaluate short-circuit currents from the aspect of DG contribution and analyze them from the aspect of relay protective functions. 5. Create a simulation model of an active grid and coordinate protection from the aspect of speed, selectivity and availability of numerical relays. 6. Evaluate different principles of passive, active and hybrid anti-island protection of distributed sources for solar, wind and biomass power plants and biogas.		
1.4. Course content		
Basic topologies of active grids and distribution of SC currents in case of faults in such grids. Characteristics of an isolated network, a resistor grounded grids and a resonant reactor grounded grids. Operating principles of current, voltage, frequency, directional protection in isolated grids, resistor grounded grids and a resonant reactor grounded grids. Characteristics of overcurrent phase and earth fault numerical relays used in isolated grids, their timing. Current characteristics. Features of voltage, frequency relays and all their settings for distributed sources in the grid. Protection characteristics of different types of distributed sources (PV, wind power, biomass and biogas power plants) and their characteristic protection. Reclosing issues impact on islanding protection settings. Parameters of protection by passive principles of voltage U>, U< frequency f>, f< and relays with functions of angle change delta theta >, change of frequency speed ROCOF(df/dt>). Active principles, anti-island protection, impedance measurement method, carrier frequency injection method, communication scheme, voltage shape change method and frequency change with examples. Application of software for coordination and simulation of numerical protection devices for parametrisation and coordination of protection in grids with distributed sources, radial scheme and loop scheme of grids.		
1.5. Types of classes	☒ lectures	☐ individual exercises

	☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1	1, 2, 4, 5	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	5	10
Preparation for laboratory exercises (LE), results analysis, report writing	2	3, 4, 5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	20	40
Preparing for an oral exam and oral exam	2	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Srete Nikolovski: Zaštita u EES-u udžbenik, ETF , Osijek 2007

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Group of authors: Novel protection systems for microgrids- TC2 Technical requirements for network protection, ABB 2009

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Srete Nikolovski: Zaštita u EES-u udžbenik, ETF , Osijek 2007	20	24

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Denis Pelin, PhD, Full Professor	
Course title	Electromagnetic Compatibility	
Study programme	Graduate university study programme in Electrical Engineering, branches: Power Engineering and Industrial Automation	
Course status	Compulsory for Industrial Automation Elective for Power Engineering	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+15+15+0+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Master the basic knowledge of electromagnetic compatibility (EMC) in order to design protection against unwanted effects of electromagnetic quantities on electrical networks, devices, systems or living organisms.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled		
1.3. Expected learning outcomes		
1. Explain and describe voltage quality indicators, their causes and consequences, and methods for improvement. 2. Assess the adverse effects of the feedback effects of power electronic converters (PEC) and loads on the grid. 3. Evaluate the procedures for determining the alternating characteristics of basic PEC and their characteristic loads. 4. Compare and apply international and European standards for the quality of electricity, define and apply the Network Rules of the electric power system. 5. Describe the sources (causes) of disturbances caused by HF field radiation. 6. Evaluate the measured radiation diagrams for different antennas.		
1.4. Course content		
Basic concepts of EMC. Non-ideal properties of components, wiring, semiconductor switches. Low frequency interference. Voltage asymmetry and harmonics, reactive power. Grounding, safety grounding, single-point versus multi-point grounding, grounding loops. Mathematical description of interferences. Harmonics in devices and systems. Alternating characteristics of non-linear and time-varying loads. Feedback effects of PEC on the grid and loads. Procedures to reduce feedbacks. Conductive disturbances. Radiated interference: symmetrical and asymmetrical currents on the example of two parallel conductors, procedures for reducing sensitivity. Crosstalk: causes, shielded conductors, twisted conductors. Shielding: protection against radiated interference, protection against high-frequency magnetic fields.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☒ other

		team work
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. Monitoring and assessment of student work		
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 student work during classes and in the final exam		

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1	1, 2, 4, 5	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	7	10
Problem-solving exercises	1	2, 3, 6	Revision exams (written exam)	Evaluation	10	20
Preparation for laboratory exercises (LE), results analysis, report writing	1	1, 2, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Problem tasks from the LF and HF part of EMC	0.5	2, 3, 6	Team work	Evaluating a solution to a given problem	4	10
Preparing for an oral exam and oral exam	1.5	1, 2, 4, 5	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Tokić, A; Milardić, M.: Kvalitet električne energije
2. I. Flegar: Elektromagnetska kompatibilnost; 1. dio: Niskofrekvencijske pojave (skripta)
3. J. Bartolić: Mikrovalna elektronika

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. P.R. Clayton: Introduction to Electromagnetic compatibility
2. J.Weidauer: Električna pogonska tehnika
3. Ph. Feracci Cahier Technique no. 199 – Power Quality
4. R.F. Harrington Time-harmonic electromagnetic fields
5. Z. Klaić**:** Mjerenje i analiza kvalitete električne energije u distribucijskoj mreži prema EN 50160

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*

Tokić, A; Milardić, M.: Kvalitet električne energije	1	15
I. Flegar: Elektromagnetska kompatibilnost; I-dio: Niskofrekvencijske pojave (skripta)	1	15
J. Bartolić Mikrovalna elektronika	5	15
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Ivan Aleksi, PhD, Associate Professor, Krešimir Nenadić, PhD, Full Professor, Željka Mioković, PhD, College Professor	
Course title	Service Learning	
Study programme	Graduate university study programme in Electrical Engineering	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	15
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	(15 + (0 + 15 + 30) + 0)

1. COURSE DESCRIPTION		
1.1. Course objectives		
Applying the service-learning method, students will be presented with the possibilities of applying, transferring and improving their acquired academic knowledge and skills from the STEM field, primarily from the field of electrical engineering, computing and information technology, to solve a specific real problem in the narrower and wider community. In this way, help them see the relevance of their knowledge and give them the feeling that they are doing something good, positive and useful for the community. Students will be directed and encouraged to teamwork and collaborative learning in designing, implementing and evaluating a service learning project through which they will be able to offer certain target groups from the community some technical and IT solutions and additional education in the field of basic and applied engineering knowledge and skills.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Distinguish socially useful learning from volunteering, student practice and socially based research. 2. Critically assess 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 thematically accompany the study programme. 3. Critically assess the methods and techniques of project activity planning and use appropriate software tools behind the creation of project documentation (project e-portfolio). 4. Manage the implementation of the project. 5. Create and present in writing and orally a project plan, final project report and project documentation (project e-portfolio).		
1.4. Course content		
During the lectures, students will be presented with basic concepts of service learning, applicable technologies for service learning, examples of good practice from the Republic of Croatia and abroad, methodology and design of service learning projects. Through laboratory exercises, students will design, prepare and practice projects. Through construction exercises, students will implement and complete projects. Through the implementation plan of the course, it is foreseen that other teachers can also design and mentor projects for service learning. Conception, preparation, implementation and evaluation of service learning projects related to the transfer of STEM competencies, in the fields of electrical engineering, energy, renewable energy sources, robotics, automation, etc.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops	☐ individual exercises ☐ multimedia and network ☐ laboratory exercises

	☒ auditory exercises ☒ distance learning ☐ field work	☒ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work		
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 student work during classes and in the final exam		

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.5	1, 2, 3, 4, 5	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	5	5
Problem-solving exercises	1	3, 4, 5	Revision exams (written exam)	Evaluation	15	30
Preparation for laboratory exercises (LE), results analysis, report writing	1	1, 2, 3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	30
Preparation for laboratory exercises (DE), results analysis, report writing	1	1, 2, 3, 4, 5	Laboratory exercises (DE)	Preparation for DE, DE supervision, DE report assessment	15	30
Preparing for an oral exam and oral exam	1	4, 5	Oral exam	Evaluation	5	10

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. N. Mikelić Preradović, Učenjem do društva znanja: teorija i praksa društveno korisnog učenja, Zagreb: Zavod za informacijske studije (2009.)
2. K.Modić Stanke, Ž. Mioković, M. Barukčić, K. Nenadić, I. Aleksi, P. Zenzerović, A. Koren Cavaleiro, M. Lulić, *Društveno korisno učenje u STEM području*, ISBN:978-953-95611-1-4, Osijek, 2019.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

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. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
N. Mikelić Preradović, Učenjem do društva znanja: teorija i praksa društveno korisnog učenja, Zagreb: Zavod za informacijske studije (2009.)	10	20
K. Modić Stanke, Ž. Mioković, M. Barukčić, K. Nenadić, I. Aleksi, P. Zenzerović, A. Koren Cavaleiro, M. Lulić, Društveno korisno učenje u STEM području, priručnik, ISBN:978-953-95611-1-4, Osijek, 2019.	20	20
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Damir Šljivac, PhD, Full Professor, Zvonimir Klaić, PhD, Associate Professor, Predrag Marić, PhD, Associate Professor	
Course title	Integration of Distributed Generation in the Power System	
Study programme	Graduate university study programme in Electrical Engineering, branch: Power Engineering	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(0+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Acquire knowledge and become familiar with valid legal and technical regulations related to the influence of distributed generation of electricity on the power system.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Identify the applicable legal and technical regulations for the integration of distributed generation from RES into power system. 2. Evaluate the impact of distributed generation from RES on power flows, short-circuit currents. 3. Evaluate the impact of distributed generation from RES on the quality of electricity. 4. Evaluate the influence of distributed generation from RES on the power system protection selectivity and stability. 5. Simulate and analyse the impact of RES integration into the power system using simple examples. 6. Independently perform and analyse measurements of the quality of electricity of RES plants.		
1.4. Course content		
Valid legal and technical regulations (network rules of transmission and distribution system) for the integration of distributed generation from RES in power system. The impact of distributed generation from RES on power flows (current-voltage conditions) and short-circuit currents in power system. The influence of distributed generation from RES on the power quality according to HE EN50160 standard. The influence of distributed generation from RES on the power system protection selectivity and stability.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	7	10
Preparation for laboratory exercises (LE), results analysis, report writing	1	5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	20	40
Preparing for an oral exam and oral exam	3	1, 2, 3, 4	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Bollen H.J.M., Hassan, F.: Integration of distributed generation in the power system, IEEE, New Jersey, 2011
2. Math H.J. Bollen Understanding Power Quality Problems, Wiley-IEEE Press; 1999
3. J. Machowski, Z. Lubosny, J. W. Bialek, J.R. Bumby: Power System Dynamics: Stability and Control, 3rd Edition, Wiley, 2020

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Nikos Hadziargyriou Microgrids, Arhitectures and Control, J. Wiley and Sons, 2014
2. D. Šljivac, D. Topić Obnovljivi izvori električne energije, sveučilišni užbenik, FERIT Osijek, 2018.
3. L. Jozsa Tokovi snaga u mreži, skripta FERIT Osijek, 2009.
4. L. Jozsa Kratki spojevi, Skripta FERIT Osijek, sveučilišni udžbenik, FERIT Osijek, 2020.
5. S. Nikolovski, D. Šljivac: Elektroenergetske mreže, zbirka zadataka, FERIT Osijek, 2002.
6. HRN EN 50160:2012, Naponske karakteristike električne energije iz javnog distribucijskog sustava
7. Valid legislative for integration of RES in Croatia
8. Transmission system grid codes, 2017.
9. Distribution system grid codes, 2018./2020.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
1. Bollen H.J.M., Hassan, F.: Integration of distributed generation in the power system, IEEE, New Jersey, 2011	1	25
2. Math H.J. Bollen Understanding Power Quality Problems, Wiley-IEEE Press; 1999	1	25
3. J. Machowski, Z. Lubosny, J. W. Bialek, J.R. Bumby: Power System Dynamics: Stability and Control, 3rd Edition, Wiley, 2020	1	25

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)		
Course title	Practical Training in Electrical Engineering	
Study programme	Graduate university study programme in Electrical Engineering, all branches	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	10
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	0+(0+0+200)+0

1. COURSE DESCRIPTION
1.1. Course objectives
Make students familiar with the working environment in the company, the organisational structure of the production-business system, managers and their responsibilities, production technology in the company, and the prescribed measures and safety procedures related to the technology used by the company. The student becomes familiar with engineering jobs and tasks, and can, under the supervision of a mentor, actively participate in these jobs, respecting safety measures, professional and technological rules, as well as other rules of the company. At the end of practical training, the student prepares a practical training report, which is in the form of usual engineering communication.
1.2. Course enrolment requirements
Requirements for enrolment in the study programme fulfilled.
1.3. Expected learning outcomes
1. Evaluate the organisational structure of the production-business system, as well as jobs and the role of managers. 2. Evaluate engineering tasks, as well as the necessary knowledge and skills related to production technology in the company. 3. Evaluate and master the prescribed safety measures and procedures related to production technology in the company. 4. Master the knowledge of engineering communication and apply it. 5. Identify the need for independent acquisition of knowledge and skills necessary for successfully solving a given complex project task based on self-assessment of one's own competencies. 6. Implement an activity plan for solving a given complex project task in the field of electrical engineering or information and communication technology. 7. Document your own solution to a given complex project task through the creation of a thesis and/or related technical report, and through the creation of presentation materials.
1.4. Course content
Students are required to complete 200 hours of practical training (on average 13 working hours per week). Each student individually realises practical training in a company in the jobs for which they are prepared through education. Under the guidance of a mentor, the student gets to know the organisational structure of the production-business system, production technology and safety at work, and gets involved in engineering work, respecting safety measures, professional and technological rules, as well as other company rules. During practical training, students are required to maintain a work diary. Practical training is organised by FERIT in cooperation with engineers employed in companies whose activity lies in the field of electrical engineering. The Faculty appoints these engineers as mentors and coordinates the students' work programmes with them. The organisation of practice is prescribed by the Ordinance on Practical Training of FERIT students.

1.5. Types of classes	☐ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☒ individual exercises ☐ multimedia and network ☐ laboratory exercises ☒ design exercises ☒ working with a supervisor ☐ other _____
1.6. Comments		

1.7. Student obligations

Defined by the Ordinance on Practical Training.

1.8. Monitoring and assessment of student work

Defined by the Ordinance on Practical Training.

1.9. Assessment and evaluation of student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at design exercises (DE)	6.5	1, 2, 3, 4	Design exercises (DE)	Attendance tracking. Minimum attendance percentage: 80%.	32	40
Problem-solving design exercises (DE)	2.5	5, 6	Problem-solving	Evaluation	15	30
Writing a practical training report	1	7	Practical training	Evaluation	15	30

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Ordinance on Practical Training of FERIT students
2. Regulations on occupational health and safety in the Republic of Croatia

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
	-	-

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)		
Course title	Master's Thesis	
Study programme	Graduate university study programme in Electrical Engineering, all branches	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	20
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	-

1. COURSE DESCRIPTION		
1.1. Course objectives		
Assign a task at the appropriate scientific and professional level for a student to demonstrate their engineering skills when working on a specific practical problem (measurement, calculation, design, circuit assembly, software development, etc.). Supervise the student in completing the assigned task.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Analyse a given complex project task in the field of electrical engineering or information and communication technology, and develop a conceptual model for its solution. 2. Independently acquire additional knowledge and skills necessary to successfully solve the given complex project task in the field of electrical engineering or information and communication technology. 3. Plan activities and resources to effectively solve the given complex project task. 4. Identify suitable research or professional methods, techniques and tools for addressing the given complex project task, ensuring relevance to the Master's thesis. 5. Implement your own solution to the given complex project task. 6. Evaluate the solution to the given complex project task, compare it with known solutions, and propose recommendations for future work and improvements.		
1.4. Course content		
Depends on the topic of the Master's thesis.		
1.5. Types of classes	☐ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☒ individual exercises ☐ multimedia and network ☐ laboratory exercises ☐ design exercises ☒ working with a supervisor ☐ other _____
1.6. Comments		
1.7. Student obligations		

Defined by the Ordinance on Final Papers and Master's Theses.

1.8. Monitoring and assessment of student work

Defined by the Ordinance on Final Papers and Master's Theses.

1.9. Assessment and evaluation of student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Defined by the Ordinance on Final Papers and Master's Theses	-	-	-	-	-	-

1.10. Obligatory literature (at the time of submitting a study programme proposal)

Depends on the topic of the Master's thesis.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

Depends on the topic of the Master's thesis.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Depends on the topic of the Master's thesis.	-	-

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Pursuant to the Ordinance on Final Papers and Master's Theses:
- the topic is approved by the Committee for Final Papers and Master's Theses,
- the graduation exam is conducted before the Master's Thesis Defence Committee.

Branch: Industrial Automation

General information		
Lead instructor(s)	Irena Galić, PhD, Associate Professor	
Course title	Digital Signal Processing	
Study programme	Graduate university study programme in Electrical Engineering, branches: Industrial Automation and Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
The student will be introduced to basic techniques for signal processing and analysis. The course will present the realisation of digital filters and the processing of signals in both the time and frequency domains.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Evaluate different methods of analog-to-digital and digital-to-analog signal conversion. 2. Assess discrete-time linear time-invariant (LTI) systems in the time domain and the transform domain. 3. Compare FIR and IIR filter design methods. 4. Design digital FIR and IIR filters using standard filter methods in MATLAB and Simulink. 5. Select and evaluate frequency analysis of signals and systems defined in the time domain. 6. Critically evaluate fast Fourier transform algorithms.		
1.4. Course content		
Introduction: characteristics and classification of discrete-time signals. Digital processing of continuous signals: sampling, aliasing, quantisation, and reconstruction. Z-transform, region of convergence, inverse transform, and properties. Discrete-time LTI systems; convolution, impulse response, and transfer function. Methods for designing IIR and FIR filters. Properties of discrete Fourier series and transform. Spectral analysis using DFT and FFT. Time windows. Multiresolution signal processing, decimation, and interpolation, polyphase decomposition. Basics of adaptive signal processing. Basics of multidimensional signal processing. Applications of DSP in communications, automation, speech, and music processing, image processing.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at: lectures (L), auditory exercises (AE), laboratory exercises (LE)	1	1-5	Lectures (L), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	0	2
Problem-solving exercises	1	1-5	Revision exams (written exam)	Evaluation	15	30
Preparation for laboratory exercises (LE), results analysis, report writing	1	1-5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	12	18
Preparing for an oral exam and oral exam	2	1-5	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. V. Oppenheim, R. W. Schafer, J. R. Buck Discrete-Time Signal Processing

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. M.H. Hayes Digital Signal Processing
2. K. Mitra Digital Signal Processing: A Computer-Based Approach

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
V. Oppenheim, R. W. Schafer, J. R. Buck Discrete-Time Signal Processing	1	30

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Dražen Slišković, PhD, Full Professor	
Course title	Industrial Informatics	
Study programme	Graduate university study programme in Electrical Engineering, branch: Industrial Automation	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+15+30+0+0

1. COURSE DESCRIPTION

1.1. Course objectives

To acquaint students with the tasks of managing and control a complex production process, and how to realise a highly computerised system for automation, from the level of connection with the technical process, through the control system and the process monitoring system, to the levels of production and business management. To acquaint students with the basics of the application of PLC, SCADA system and industrial communication system, which is the basis for the practical implementation of systems for automatic control of various industrial processes. To acquaint students with informatisation/computerisation in these systems and the most important software systems and tools.

1.2. Course enrolment requirements

Requirements for enrolment in the study programme fulfilled.

1.3. Expected learning outcomes

1. Describe the ways of managing a complex technical (production) process and explain what informatisation and automation are in process management and control.
2. Describe the structure and mode of operation of a process computer and its implementation in the form of a programmable logic controller.
3. Choose a PLC configuration and write a control/user program for simpler and more complex tasks.
4. Explain the advantages and disadvantages of (de)centralisation in the realization of a system for automatic process control.
5. Describe the role and structure of SCADA software support, and its main interfaces.
6. Define the requirements for the communication system at individual levels of managing and control and choose appropriate communication for a specific purpose.
7. Establish communication, with several communication standards, using Simatic equipment.

1.4. Course content

Production system and industrial plant. Process management and control and stratification of related tasks. Informatisation and automation of the production system. The basic structure of the system for automatic process control. Examples from practice. Digital realisation of the control system. Process computer and programmable logic controller (PLC). Process peripherals - sensors and actuators and connection to the process computer. Control unit - the central unit of the system for automatic process management and control. Control unit structures: centralised and decentralised, hierarchical and distributed. Supervisory unit - subsystem for operator-production system interfacing and process database. Structures of the supervisory unit and ways of managing the modern automated system. Supervisory control. Equipment for the implementation of the control unit and supervisory unit. SCADA system. Computerisation of production and business management - MES and ERP systems. Industry 4.0. Computer/digital communication systems for application in industry. General purpose communication technologies/standards. Bus and network communication. Industrial communication standards. Communication at the field level and at higher (management) levels. ProfiBus, MPI,

CAN, ASI, Industrial Ethernet, ProfiNet. Software support in automation systems and user software tools. Examples of complete systems; for the control and automation of production systems and for monitoring the automated production system.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☐ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE)	2.5	1, 2, 3, 4, 5, 6, 7	Lectures (L), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	2	5
Preparation for laboratory exercises (LE), results analysis, report writing	1.7	3, 6, 7	Laboratory exercises (LE)	Checking of preparation for LE, LE supervision, LE report assessment	12	30
Problem-solving exercises	1.3	3, 4, 5, 6	Revision exams (written exam)	Evaluation	15	30
Preparing for an oral exam and oral exam	1.5	1, 2, 4, 5, 6	Oral exam	Evaluation	18	35

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Slišković, D. Procesna automatizacija – predavanja, zavodska skripta

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Perić, N. Automatizacija postrojenja i procesa - predavanja
2. Crispin, A. J. Programmable Logic Controllers and their Engineering Applications
3. Jović, F. Kompjutersko vođenje procesa

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*

Slišković, D. Procesna automatizacija – predavanja	15	15
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Robert Cupec, PhD, Full Professor	
Course title	Basics of Robotics	
Study programme	Graduate university study programme in Electrical Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+30+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Learn basic concepts in 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 application of robots. Teach students to understand and apply methods from the robotics field for robot manipulator. Learn basic concepts of integrating robots in a manufacturing process.		
1.2. Course enrolment requirements		
Requirements met for enrolling in the study programme.		
1.3. Expected learning outcomes		
1. Formulate kinetic models of robot manipulators based on their mechanical specifications using Denavit-Hartenberg method. 2. Write a computer programme function for robot tool positioning by solving the inverse kinematics problem for 6-axis robot manipulator with rotational joints where the last three axes intersect in a single point. 3. Create a dynamic model of a simple robot manipulator using the Lagrange-Euler method. 4. Explain basic robot manipulator control methods. 5. List the basic types of motors and sensors used in robotics and explain the basic applications of sensors in robotics. 6. Develop a basic computer program for the control of a robot manipulator and a CNC machine. 7. Explain how to use robots and CNC machines in a simple manufacturing process.		
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. CNC and additive manufacturing. Modelling of flexible manufacturing systems by Petri networks.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☐ distance learning ☐ field work	☒ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	max
Attendance Lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 5, 7	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	3	10
Problem-solving exercises	1	1, 2, 3, 6, 7	Revision exams (written exam)	Evaluation	12	30
Preparation for laboratory exercises (LE), results analysis, report writing	0.8	1, 2, 3, 6, 7	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	8	20
Preparing for an oral exam and oral exam	1.2	4, 5, 7	Oral exam	Evaluation	20	40

1.10. Obligatory literature

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

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

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. R. Cupec, Basics of intelligent robotrs, teaching materials, FERIT Osijek, 2018

1.12. *Number of obligatory literature copies in relation to the number of students currently taking the course*

Title	*Number of copies*	*Number of students*
1. Kovačić Z.; Bogdan, S; Krajči, V. Osnove robotike. Zagreb: Graphis, 2002.	5	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Kruno Miličević, PhD, Full Professor, Vedrana Jerković Štil, PhD, Assistant Professor	
Course title	Supervisory Systems in Industry	
Study programme	Graduate university study programme in Electrical Engineering, branch: Industrial Automation	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(0+30+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Present to students the implementation of systems for collecting, processing, and displaying process measurement data. Familiarise students with the methods of describing the associated processes and systems. Present the systematisation of connecting business logistics and the production process in accordance with relevant standards. Demonstrate the application of methods and tools for system improvement according to the principles of digital transformation.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Describe an industrial system using standard notations for process description. 2. Understand the elements at all levels of a supervisory system. 3. Interpret and analyse the documentation of a supervisory system. 4. Apply the systematisation of connecting business logistics and the production process to an industrial system according to relevant standards. 5. Maintain the supervisory system throughout all phases of its lifecycle. 6. Propose the application of methods and tools for system improvement according to the principles of digital transformation.		
1.4. Course content		
Special conditions for technical systems in industrial (production, technological, and energy) plants. Architecture of supervisory systems (automation pyramid), interconnection of different levels. Local and telemetry supervisory systems. Distributed supervisory systems. Control rooms for critical infrastructure. Integration of business logistics and the production process. Relevant standards and systematizations, e.g., ANSI/ISA-95, PERA/PRM. Process notation (UML, BPMN, and B2MML). Symbols in process and instrumentation diagrams, documentation creation, and project management in supervisory and control systems. Hardware and software solutions for supervisory systems in industry, historical overview, and development trends. Supervisory systems according to the principles of digital transformation. Application of machine learning and artificial intelligence methods, predictive maintenance, digital twins, and virtual commissioning, application of augmented reality, types of HMI. Lifecycle of supervisory systems.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises

	☐ distance learning ☒ field work	☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2.5	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Preparation for laboratory exercises (LE), results analysis, report writing	2	2, 3, 4, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	25	50
Preparing for an oral exam and oral exam	2.5	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Norma ANSI/ISA-95, International Society of Automation
2. Mario Lučan, Goran Malčić, Danijel Maršić, Ivica Vlašić, Sustavi upravljanja i nadzora postrojenja, Tehničko veleučilište u Zagrebu, 2021.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Pegn Zhang, Advanced Industrial Control Technology, 2010 Elsevier Inc
2. Masoud Soroush, McKetta Michael Baldea, Thomas Edgar, Smart Manufacturing Concepts and Methods, Elsevier, 2020

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Norma ANSI/ISA-95, International Society of Automation	5	15
Mario Lučan, Goran Malčić, Danijel Maršić, Ivica Vlašić, Sustavi upravljanja i nadzora postrojenja, Tehničko veleučilište u Zagrebu, 2021.	3	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Marinko Barukčić, PhD, Associate Professor, Željko Hederić, PhD, Full Professor	
Course title	Design in Industrial Systems	
Study programme	Graduate university study programme in Electrical Engineering, branch: Industrial Automation	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + (auditory exercises + laboratory exercises + design exercises) + seminars)	30+(15+0+30)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Understand the structure of industrial plants; material, energy and information flows in the system of monitoring and process control. Analysing the process of planning and preparing supporting documentation, i.e. selecting suitable equipment and technical solutions. Understand the communication processes in the monitoring and control system to connect control systems through industrial communication networks to automate equipment. The ability to perform an electromagnetic calculation of an electrical machine.		
1.2. Course enrolment requirements		
Requirements for enrolment in the first year of study fulfilled.		
1.3. Expected learning outcomes		
Determine the relationships between the flows of matter, energy and information in various technical processes. Analyse the flow of data in industrial communication networks. Determine the basic quantities needed to create an electrical design. Define the necessary parts of technical documentation. Analyse technical documentation (preliminary, main and implementation documentation). Use a CAD tool to create technical documentation for an industrial control cabinet. Perform a basic calculation of the magnetic circuit and the parameters of the electrical machine. Apply a FEM tool for electromagnetic calculation.		
1.4. Course content		
The structure of an industrial plant. Specific conditions for technical systems in industrial plants (production, technology and energy plants). Analysing material, energy and information flows in various technical processes. Concepts of project and project management. Choice of equipment and technical solution. A modern approach to design (CAD). Technical documentation – Croatian technical regulations in the development of projects in the field of electrical engineering. Description of components and use of the CAD system. Flowchart of preliminary and detailed design. Symbols for basic electrotechnical, electronic and electromechanical elements and assemblies. Typical schematics - power and control. Process diagrams (P&ID – piping and instrumentation diagrams). Types, development and use of schematics in the electrical engineering profession. Basics of working in Eplan and Solidworks. Basics of manufacturing and testing electrical and control cabinets for industrial installations. Selection of electrical materials for the construction of machinery and equipment. Determination of the main dimensions of transformers, synchronous and asynchronous machines. Application of the 2D and 3D finite element method in electromagnetic calculations.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops	☒ individual exercises ☐ multimedia and network

	☒ auditory exercises ☒ distance learning ☐ field work	☐ laboratory exercises ☒ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance atlectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 7	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Solving tasks	1.5	3, 5, 7	Control tasks (written exam)	Checking solved tasks	14	28
Preparation for laboratory exercises (LE), results analysis, report writing	1	6, 8	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Independent work	0.5	5	Instructions and tasks for independent work	Verification and explanation of the results of independent work	6	12
Preparing for an oral exam and oral exam	1	1,2,3,4,7	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Kahle Franjo H, Design and Construction of Machines

2. Srb Vjekoslav, Electrical installations and low-voltage networks

3. Amir Halep, Electrical and Lighting

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Collection of Regulations for Taking the Professional Exam in the Electrical Engineering Profession, Electrotechnical Society Zagreb, 2014

2. IET Electrical Installation Design Guide: Calculations for Electricians and Designers

3. Bernd Gischel (2015.), EPLAN Electric P8 Reference Handbook

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Kahle Franjo H, Design and Construction of Machines	3	15
Srb Vjekoslav, Electrical installations and low-voltage networks	2	15
Amir Halep, Electrical and Lighting	3	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Vedrana Jerković Štil, PhD, Assistant Professor	
Course title	Dynamics of Industrial Systems	
Study programme	Graduate university study programme in Electrical Engineering, branch: Industrial Automation	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+30+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Present the types of hydraulic and pneumatic actuators as part of electro-pneumatic and electro-hydraulic industrial systems. Introduce the calculation of losses and energy efficiency of electric drives. Explain the interaction of electrical industrial plants and power system. Present the steps of designing electrical drives according to requirements industrial system. Analyse the types of electric motor drive protection and the term functional safety. Present the procedures of testing, diagnostics and monitoring of electric motor drives.		
1.2. Course enrolment requirements		
Fulfilled requirements for enrollment in the second year of study.		
1.3. Expected learning outcomes		
1. Create electrical drives dynamic models of industrial systems. 2. Perform simulations of the operation of electric drives in the required operating modes. 3. Analyse the mutual influence of the industrial plant and the power system in normal and malfunctioning modes of operation. 4. Propose adequate protection of the electric drive from unwanted influences originating from the power supply and working mechanism. 5. Propose the optimal choice of electric drive with regard to the requirements of the working mechanism and technological conditions in the industrial plant. 6. Assess the state of the electrical machine in operation based on the available measurements.		
1.4. Course content		
Types of hydraulic and pneumatic actuators. Losses and energy efficiency of electric drives. The interaction of industrial plants and the power system during sudden load changes and malfunction states. Designing electrical drives according to the requirements of the industrial system. Protection and functional safety. Testing, diagnostics and monitoring of electrical drives.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Problem-solving exercises	0.5	1, 3	Revision exams (written exam)	Evaluation	10	20
Preparation for laboratory exercises (LE), results analysis, report writing	1	1, 2, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	30
Preparing for an oral exam and oral exam	1.5	1, 3, 4, 5	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Weidauer, Jens: Električna pogonska tehnika (prijevod; hrvatsko izdanje), Graphis, Zagreb, 2013.
2. V. Ambrožić, P. Zajec: Električni servo pogoni, Graphis, Zagreb, 2019.
3. M. Jadrić, B. Frančić: Dinamika električnih strojeva, Graphis, Zagreb, 1995.
4. B. Jurković: Elektromotorni pogoni, ŠK, Zagreb, 1990.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Kaltjob, Patrick: Mechatronic Systems and Process Automation, CRC Press, 2018.
2. Zhang, Peng: Advanced Industrial Control Technology, Elsevier, 2010.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Weidauer, Jens: Električna pogonska tehnika (prijevod; hrvatsko izdanje), Graphis, Zagreb, 2013.	2	15
V. Ambrožić, P. Zajec: Električni servo pogoni, Graphis, Zagreb, 2019.	2	15
M. Jadrić, B. Frančić: Dinamika električnih strojeva, Graphis, Zagreb,1995.	2	15
B. Jurković: Elektromotorni pogoni, ŠK, Zagreb, 1990.	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lecturer(s)	Dražen Slišković, PhD, Full Professor	
Course title	Data-Based Modelling	
Study programme	Graduate university study programme in Electrical Engineering, branch: Industrial Automation	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+0+30+0+0

1. COURSE DESCRIPTION

1.1. Course objectives

To make students familiar with the basics of the methodology of extracting knowledge about the process contained in the available measurement data, and how to build a process model with the desired properties based on this information. Acquiring appropriate skills in working with available software tools for analysis and processing of measurement data, as well as tools for building process models based on this data. To acquaint students with the method of improving the automatic control system based on the knowledge extracted from measurement data and the method of building a fault-tolerant system, as the forms of introducing intelligence into the technical system.

1.2. Course enrolment requirements

Requirements for enrolment in the second year of study fulfilled.

1.3. Expected learning outcomes

1. Collect, analyse and pre-process measurement data, and create data sets for model building.
2. Highlight the advantages and disadvantages of a particular method of identification for a particular problem of process identification.
3. Create a dynamic mathematical model of the process with several identification methods implemented in the Matlab software package.
4. Explain the problems of process monitoring and control system realisation with the existence of a malfunction in the measurement system, as well as the existence of a difficult-to-measure process variable, and the way to solve the problem by applying a process variable estimator (soft-sensor).
5. Explain the problem of building a model based on high-dimensional plant data and the mathematical basis for building a model with good predictive properties.
6. Evaluate the suitability of a particular method based on the projection of the input data space into the latent space for the given problem of process modeling and building of the process variable estimator.
7. Build a process variable estimator based on plant data, applying the analysed methods, using the Matlab software package.

1.4. Course content

Modelling processes and other functional relationships in data, based on measurement data. Measurement data obtained in a separate experiment and operational (plant) data. Informativeness of measurement data. Analysis and preprocessing of measurement data and the formation of data sets for the building of process models. Construction of a static and dynamic process model. Non-parametric and parametric methods of identification. Non-recursive and recursive methods of model parameter estimation. Estimation of a process variable based on information about other quantities that are related to it. Selection of model structure and input variables. Building models based on high-dimensional data. Regression modeling and criteria for estimating model parameters. Methods based on the projection of the input space into the latent (sub)space. Linear and non-linear modeling methods. Application of artificial neural networks in data based modeling.

Validation/evaluation of models built on the basis on data. Application of the Matlab software package in data-based modeling. Virtual (soft) sensor and its implementation.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☐ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☒ other - project assignment of choice
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), laboratory exercises (LE)	2	1, 2, 3, 4, 5, 6, 7	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	5	8
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	1, 3, 6, 7	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	30
Solving project assignment	1	1, 2, 3, 4, 5, 6, 7	Individual work	Project report assessment	0	25
Preparing for an oral exam and oral exam	1.5	1, 2, 4, 5, 6	Oral exam	Evaluation	20	37

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Slišković, D., Modeliranje temeljeno na podacima – predavanja, zavodska skripta

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Fortuna, L., S. Graziani, A. Rizzo, M.G. Xibilia; Soft sensors for Monitoring and Control of Industrial Processes
2. Ljung, L., System Identification - Theory for the User
3. Martens, H., T. Naes, Multivariate Calibration, 2nd edition
4. Haykin, S., Neural Networks – A Comprehensive Foundation, 2nd edition

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Krešimir Grgić, PhD, Associate Professor, Kruno Miličević, PhD, Full Professor	
Course title	Cybersecurity in Industrial Systems	
Study programme	Graduate university study programme in Electrical Engineering, branch: Industrial Automation	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+30+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To familiarise students with cybersecurity issues in the industrial environment (risk assessment, understanding existing security threats, possible attacks and available prevention and detection measures). To teach students the basic principles of modern cryptographic systems, and to familiarise them with the methods of their application in various security protocols. To train students to correctly plan, implement and maintain the most important security mechanisms in industrial systems.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Understand and describe the basic principles of modern cryptographic systems and the possibilities of their application. 2. Understand and explain existing security threats, attacks and risks in the industrial environment. 3. Understand and apply different security mechanisms for the prevention and detection of attacks in industrial systems 4. Analyse and evaluate security requirements, and plan and implement security policy and mechanisms in industrial systems		
1.4. Course content		
Basic security premises and terms. Basic cryptographic terms. Symmetric cryptosystems and their application. Asymmetric cryptosystems and their application. Key management. Security aspects of industrial communication protocols. Security threats and malware. Types of attacks and possible countermeasures. Types and configuration of firewalls. Detection and prevention of unauthorised intrusions. Security policy, risk assessment and management.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☒ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), laboratory exercises (LE)	2	1, 2, 3, 4	Lectures (L), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Preparation for laboratory exercises (LE), results analysis, report writing	2	1, 2, 3, 4	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	25	50
Preparing for an oral exam and oral exam	2	1, 2, 3, 4	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. A. Dujella, M. Maretić, Kriptografija, Element, Zagreb, 2007.
2. P. Ackerman, Industrial Cybersecurity, Packt Publishing, Birmingham, 2021.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. W. Stallings, Cryptography and Network Security (7th edition), Pearson, 2017.

2. Clint Bodungen, Bryan Singer, Aaron Shbeeb, Kyle Wilhoit, Stephen Hilt, Hacking Exposed Industrial Control Systems: ICS and SCADA Security Secrets & Solutions, McGraw Hill Professional, 2016.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
A. Dujella, M. Maretić, Kriptografija, Element, Zagreb, 2007.	2	15
P. Ackerman, Industrial Cybersecurity, Packt Publishing, Birmingham, 2021.	2	15
W. Stallings, Cryptography and Network Security (7th edition), Pearson, 2017.	2	15
Clint Bodungen, Bryan Singer, Aaron Shbeeb, Kyle Wilhoit, Stephen Hilt, Hacking Exposed Industrial Control Systems: ICS and SCADA Security Secrets & Solutions, McGraw Hill Professional, 2016.	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Željko Hederić, PhD, Full Professor, Tomislav Barić, PhD, Full Professor	
Course title	Numerical Methods in Electromagnetism	
Study programme	Graduate university study programme in Electrical Engineering, branch: Industrial Automation	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+30+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To present to students mathematical models of electric and magnetic fields and procedures for solving numerical integration and differentiation. Introducing students to the basics of numerical methods in electromagnetism. To train students for field calculations by using modern software tools for numerical calculations.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Use basic physical laws and mathematical models to describe electric and magnetic fields, solving fields using numerical integration and differentiation. 2. To understand and apply iterative methods in solving systems of equations. 3. Critically analyse the simulation results using the finite difference method. 4. Critically analyse the results of simulations using the finite element method (FEM). 5. Critically analyse the results of simulations using the method of moments (boundary element method - BEM). 6. Create models in commercial FEM and BEM programs for analysis and synthesis of engineering tasks.		
1.4. Course content		
The course examines the principles and application of numerical methods for solving practical electromagnetic problems (computational electromagnetism). Method of moments (also known as boundary element method - BEM) with application to electrostatics (distribution of charge on bodies), distribution of currents in grounding systems, antennas (radiation diagrams and distribution of antenna currents), wave on transmission line. Finite difference method: heat conduction. Finite element method (FEM): heat conduction, magnetostatics. Hybrid methods. At the same time, the application of traditional analytical methods in electromagnetism is investigated: the solution of integral-differential equations for which there is a solution with application to the determination of capacitance and inductance, distribution of charges and currents, etc. Computer programming: development of algorithms for the application of methods of moments, finite differences and finite elements for the above given examples in practice.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☒ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor

		☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L)	1	1, 2, 3, 4, 5, 6	Lectures (L)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Laboratory exercises (LE), preparation for laboratory exercises (LE), results analysis, report writing	1	2, 3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	25	50
Independent exercises	1	2, 3, 4, 5, 6	Instructions and assignments for exercises	Evaluation	0	10
Preparing for an oral exam and oral exam	1	2, 3	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Z. Haznadar, Elektromagnetska teorija i polja, Liber, Zagreb, 1972.
2. S. Berberović, Teorijska elektrotehnika–odabrani primjeri, Graphis, Zagreb,1998.
3. Sadiku, Matthew N.O. Numerical Techniques in Electromagnetics. CRC Press, 2000.
4. Haznadar, I; Štih, Z. Elektromagnetizam I i II. Zagreb: Školska knjiga, 1997.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. W.H.A. Schilders, E.J.W. ter Maten, Numerical Methods in Electromagnetics, Vol. 13: Special Volume, ELSEVIER,North Holland, 2005,

2. Z. Haznadar, Ž. Štih, Elecromagnetics Fields, Waves and Numerical Methods, IOS Press, Ohmsha, Amsterdam, Vol. 20, 2000.

3. Matthew N.O. Sadiku, Numerical Techniques in Electromagnetics, CRC Press; 2 edition, 2000

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Z. Haznadar, Elektromagnetska teorija i polja, Liber, Zagreb, 1972.	3	12

S. Berberović, Teorijska elektrotehnika–odabrani primjeri, Graphis, Zagreb, 1998.	2	12
Matthew N.O. Sadiku, Numerical Techniques in Electromagnetics. CRC Press, 2000.	2	12
Haznadar, I; Štih, Z. Elektromagnetizam I i II. Zagreb: Školska knjiga, 1997	3	12
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Željko Hederić, PhD, Full Professor, Denis Pelin, PhD, Full Professor	
Course title	Propulsion Systems and Power Supplies for Vehicles	
Study programme	Graduate university study programme in Electrical Engineering, branch: Industrial Automation	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + (auditory exercises + laboratory exercises + design exercises) + seminars)	30+(0+30+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To teach students the fundamentals of vehicle dynamics and the basics of modelling energy and power requirements. To introduce students to the topology of vehicle propulsion (classic, electric, hybrid) and to introduce them to electric machines for the propulsion of electric vehicles (division, operating modes, basics). Students should familiarise themselves with typical devices inthe vehicle, their power supply systems and energy storage systems in the vehicle. Describe the basic options for controlling energy flows in the vehicle using electronic energy converters. Introduce the students to sensors and actuators in the vehicle. Introduce students to wiring, relays and contactor systems for different voltage levels.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Create models of vehicle propulsion to understand the fundamentals of dynamics and analyse simulation results. 2. Analyse the basic possibilities of controlling energy flows in the vehicle using electronic energy converters. 3. Understand the functional principle, components and role of electric machines in the vehicle drive system. 4. Classify power supply and energy storage systems for electric vehicles. 5. Create models of basic energy storage systems in the vehicle and critically analyse the results of the working simulations.		
1.4. Course content		
The fundamentals of vehicle dynamics, the physics of motion and the demand for energy and power. Basic components of vehicle propulsion, drive topologies (classic, electric, hybrid), basics of modelling energy and power flows based on dynamic parameters of the vehicle in different driving modes. Fundamentals of electric machines for vehicle drive systems, functional principles, parameters and control types as well as the basics of modelling. Typical consumers and energy storage systems in a vehicle. Electronic energy converters for connecting consumers and energy storage systems in the vehicle. External charging systems for electric vehicles. Control systems for the operation of battery packs in electric vehicles. Actuators and sensors in the vehicle drive, on-board networks, relays and contactors for different voltage levels.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning	☒ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor

	☐ field work	☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.0	1, 2, 4	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Preparation for laboratory exercises (LE), results analysis, report writing	1.0	3	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	20	40
Independent work	1.0	3, 5	Instruction and tasks for independent work	Verification and explanation of the results of independent work	10	20
Preparing for an oral exam and oral exam	1.0	1, 2, 4	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. B. Skalicki: Electric Machines and Drives, Zagreb FESB 2004
2. I. Flegar: Electronic Power Converters, Kigen, Zagreb, 2010
3. Seref Soylu: Electric Vehicles - Modelling and Simulations, open access - InTech, DOI: 10.5772/958

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

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

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
B. Skalicki: Electric Machines and Drives	2	11
I. Flegar: Electronic Power Converters	2	11
Seref Soylu: Electric Vehicles - Modelling and Simulations	1	11
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Marinko Barukčić, PhD, Associate Professor	
Course title	Optimisations and Estimations in Electrical Engineering	
Study programme	Graduate university study programme in Electrical Engineering, branch: Industrial Automation	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+30+0)+0

1. COURSE DESCRIPTION

1.1. Course objectives

Introduce students to optimisation and estimation procedures in distributive and industrial networks. Familiarise students with computer tools for optimisation in the Python programming environment. Enable students to solve simpler optimisation problems in distributive and industrial networks using methods of artificial intelligence and co-simulation of computer tools.

1.2. Course enrolment requirements

Requirements for enrolment in the second year of study fulfilled.

1.3. Expected learning outcomes

1. Classify optimisation problems in electrical engineering and appropriate methods for solving them.
2. Formulate optimisation and estimation problems in electrical engineering.
3. Propose an appropriate method for optimisation and estimation in electrical engineering.
4. Integrate software tools for electrical system analysis and methods of artificial intelligence for solving optimisation problems in electrical engineering.
5. Create a procedure for solving optimisation problems in electrical engineering that includes problem formulation and solving using co-simulation of software tools.

1.4. Course content

- Overview of methods of artificial intelligence: evolutionary algorithms, fuzzy inference systems, and artificial neural networks.
- Mathematical formulation of single-objective optimisation problems.
- Mathematical formulation of multi-objective optimisation problems. Pareto definitions in multi-objective optimisation.
- Examples of simple and moderately complex optimisation and estimation problems: optimal allocation of devices (volt-var devices, distributed generation, filters, etc.), estimation of voltage profile, estimation of parameters in substitute device schemes (transformer, motor, line, etc.).
- Optimisation and estimation through co-simulation of two software packages: Python packages for artificial intelligence methods and their application with software for simulating electrical systems (open-access tools).

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises	☒ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises

	☒ distance learning ☐ field work	☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work		
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 student work during classes and in the final exam		

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.0	1, 2, 3	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Problem-solving exercises	1.0	2, 4, 5	Revision exams (written exam)	Evaluation	20	40
Preparation for laboratory exercises (LE), results analysis, report writing	1.0	2, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Preparing for an oral exam and oral exam	1.0	1, 2, 4, 5	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. D. K. Chaturvedi, Soft Computing Techniques and its Applications in Electrical Engineering, 2008, Springer Berlin Heidelberg (http://www.springer.com/gp/book/9783540774808)

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

2. C. Coello Coello, G. B. Lamont, D. A. van Veldhuizen, Evolutionary Algorithms for Solving Multi-Objective Problems, 2007, Springer US (http://www.springer.com/gp/book/9780387332543)
3. Lei, G.; Zhu, J.; Guo, Y.; Liu, C.; Ma, B. A Review of Design Optimization Methods for Electrical Machines. Energies 2017, 10, 1962. https://doi.org/10.3390/en10121962
4. Y. Wang, S. Mao, R. M. Nelms, Online Algorithms for Optimal Energy Distribution in Microgrids, 2015, Springer International Publishing (https://link.springer.com/book/10.1007/978-3-319-17133-3)
5. R. Kruse, C. Borgelt, F. Klawonn, C. Moewes, M. Steinbrecher, P. Held, Computational Intelligence A Methodological Introduction, 2013, Springer London (https://link.springer.com/book/10.1007/978-1-4471-5013-8

6. C. A. Coello Coello, A Short Tutorial on Evolutionary Multiobjective Optimization, On-line: http://ftp.bstu.by/ai/To-dom/My_research/Papers-0/For-lecture/Moga/tutorial-slides-coello.pdf, (26 June 2017)

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
D. K. Chaturvedi, Soft Computing Techniques and its Applications in Electrical Engineering, 2008, Springer Berlin Heidelberg	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

Branch: Communications and Informatics

General information		
Lead instructor(s)	Slavko Rupčić, PhD, Full Professor	
Course title	Electromagnetic Fields and Waves	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Familiarise students with the laws of electromagnetic field generation and the generation and propagation of electromagnetic waves. Introduce students to the methods used to analyse problems in electromagnetism.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Analyse and evaluate fundamental phenomena, quantities and laws of electromagnetism (EM fields and waves). 2. Apply the fundamental laws of electromagnetic theory to calculate the fundamental quantities of electromagnetic waves. 3. Evaluate the properties of methods and techniques suitable for solving the problem of electromagnetic wave propagation and radiation of electrically short antennas. 4. Develop and apply a mathematical formulation for analysing simple cases of plane wave propagation and radiation from electrically short antennas. 5. Develop and evaluate simple programming systems and utilise commercial software packages to solve propagation and radiation problems. 6. Formulate the theoretical settings of transmission lines and waveguides.		
1.4. Course content		
Physical principles of electrical engineering in the presentation of field theory. Basic laws of electric and magnetic fields. Maxwell's equations. Boundary conditions. Poynting theorem and Poynting vector – energy balance of the EM field. Vectorial and scalar EM potentials. Electrostatic field. Bio-Savart's law, self-inductance and mutual induction. Introduction to the theory of EM waves. Plane wave: basic properties, reflection and refraction, propagation modes, energy density, power flow, polarisation. A plane wave in a dispersive medium, attenuated waves in a conductor. Propagation of EM waves in free space. Helmholtz equation. Elementary electric dipole. Transmission lines and waveguides.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor

	☐ field work	☐ other _____
1.6. Comments	Lessons can be held in 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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance atlectures (L), auditory exercises (AE), laboratory exercises (LE)	1	1, 2, 3, 4, 5, 6	Lectures (L), auditory exercises (AE), laboratory exercises (LE),	Attendance tracking. Minimum attendance percentage: 70%.	2	5
Problem-solving exercises	3.5	2, 3, 4, 5, 6	Revision exams (written exam)	Evaluation	23	45
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	2, 4, 5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Preparing for an oral exam and oral exam	1	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	15	30

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Bartolić, J. Mikrovalna elektronika. Zagreb: Graphic, 2012.
2. Balanis, C. A. Advanced Engineering Electromagnetics, 2nd Edition. Wiley, 2012.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. E. C. Jordan, K. G. Balmain, Electromagnetic waves and radiating systems, Prentice-Hall, Inc. Englewood Cliffs, N.J, 1968.
2. R. F. Harrington, Time-harmonic electromagnetic fields, McGraw-Hill, New York, 1961.
3. J. Kraus, Electromagnetics, McGraw Hill, N.Y. 1984.
4. Z. Haznadar, Elektromagnetska teorija i polja, Liber, Zagreb, 1972.
5. E. Zentner, Radiokomunikacije, Školska knjiga, Zagreb, 1989.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Bartolić, J. Mikrovalna elektronika. Zagreb: Graphic, 2012.	1	15
Balanis, C.A. Advanced Engineering Electromagnetics, 2nd Edition. Wiley, 2012.	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Drago Žagar, PhD, Full Professor, Krešimir Grgić, PhD, Associate Professor	
Course title	Computer Networks	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+15+0)+0

1. COURSE DESCRIPTION

1.1. Course objectives

Students will acquire knowledge necessary for designing and implementing a computer network. By successfully completing the course, students will be able to design and dimension basic parameters and optimize computer network performance.

1.2. Course enrolment requirements

Requirements for enrolment in the first year of study fulfilled.

1.3. Expected learning outcomes

1. Evaluate the properties of different network topologies in combination with different switching principles (channels or packets) with the aim of their classification.
2. Evaluate the properties of different network architectures with regard to the used protocols and addressing principles with the aim of their classification.
3. Implement mechanisms and methods for flow control and congestion control in the computer network
4. Assess and evaluate access control techniques (procedures) depending on the properties of the transmission medium and the required transmission characteristics.
5. Understand and apply mechanisms and architectures for the integrated implementation of quality of service for the various requirements of modern network applications.
6. Apply methods and tools for measuring and optimising the performance of computer networks.

1.4. Course content

Network topologies. LAN, MAN, WAN, wireless networks. Calculation of the capacity of simple and complex network structures, the rule of minimum cut - maximum flow. Basics of traffic theory in computer networks. Parameters and properties of the serving system. Basic models of serving systems. Kendall's relations and basic distributions. Packet scheduling and forwarding algorithm (PQ, WFQ, CBWFQ, LLQ, etc.). Implicit and explicit congestion control in the computer network. Flow control in a computer network. Timer control for retransmission, RFC 793. Jacobson's algorithm, Karn's algorithm. Implementation of explicit congestion control in TCP and IP protocol. Quality of service in computer networks QoS. Application requirements on QoS. Mechanisms for realizing the quality of service in the network: traffic shaping, packet distribution, access control. Basic architectures for achieving service quality: model of integrated services, model of differentiated services. Service Level Agreement SLA. MPLS. Hybrid QoS models. Real-time traffic in computer networks. RTP and RTCP protocol. SIP protocol. SDP protocol. Hierarchical network model, task of individual layers. VLAN organization of computer networks. Issues and methods of multiple access to a shared medium in wired and wireless networks. Fairness models of media sharing in WLAN networks. Connecting computer networks. Spanning tree protocol. Advanced routing algorithms. Computer network management, SNMP. Software-defined networks SDN. Hybrid SDN network. Design and optimisation of the computer network. Regulatory aspects of computer networks. Applications of computer networks.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE)	1.5	1, 2, 3, 4, 5, 6	Lectures (L), auditory exercises (AE), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	1	4
Problem-solving exercises	1.5	2, 3, 4, 5, 6	Revision exams (written exam)	Evaluation	16	32
Preparation for laboratory exercises (LE), results analysis, report writing	1	1, 2, 3, 4, 5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	12	24
Preparation and presentation of the seminar paper	0.5	2, 3, 4, 5	Preparation and presentation of the seminar paper	Verification of the content of the seminar work and presentation of the results	6	10
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	15	30

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. A. Bažant, et al, Osnovne arhitekture mreža, Element Zagreb, 2014.
2. A.S. Tanenbaum, Computer Networks, Fifth Edition, Prentice Hall, 2010.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. J. Kurose, K. Ross, Computer Networking: A Top-Down Approach, 8th edition, Pearson, 2021.
2. W. Stallings, Data and Computer Communications, Tenth Edition, Macmillan Publishing Company, New York, 2014.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course		
Title	*Number of copies*	*Number of students*
A. Bažant, et al, Osnovne arhitekture mreža, Element Zagreb, 2014	5	25
A.S. Tanenbaum, Computer Networks, Fifth Edition, Prentice Hall, 2010.	1	25
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Marijan Herceg, PhD, Associate Professor, Josip Job, PhD, Associate Professor	
Course title	Advanced Programming	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+0+15+15+0

1. COURSE DESCRIPTION

1.1. Course objectives

The objective of the course is to enable students to independently and systematically develop specialised software using available libraries and mechanisms offered by programming languages, operating systems, and hardware. The intention is to develop an understanding among students of the relationships and dependencies between software and hardware architecture.

1.2. Course enrolment requirements

Requirements for enrolment in the study programme fulfilled.

1.3. Expected learning outcomes

1. Manage the process of program code compiling for the target architecture.
2. Evaluate the memory usage efficiency in some code and suggest possible improvements.
3. Develop your own software solution for a given simple problem for the target architecture.
4. Identify and correct errors in the dedicated software support during its development.
5. Assess the correctness of the developed software solution.

1.4. Course content

Tasks of software and its specifics. Development and testing of software. A deeper understanding of elements of the C programming language that are significant for writing software: size and representation of basic types; variables and their representation in the physical architecture; memory allocation mechanisms; functions; pointers; structures, unions, and memory alignment. Code translation. Version control systems. Basic data structures. Extensions of the C programming language.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☒ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1	1, 2, 3, 4, 5	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Preparation for laboratory exercises (LE), results analysis, report writing	1	3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	30
Solving problems assigned in design exercises	1	1, 3, 4, 5	Design exercises	Evaluation of the solution for the given problem	15	30
Preparing for an oral exam and oral exam	2	1, 2, 3, 4, 5	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. C11 - ISO/IEC 9899:201x Committee Draft April 12, 2011 N1570, International Organization for Standardization/International Electrotechnical Commission, 2011.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Brian W. Kernighan, Dennis M. Ritchie, C Programming Language, 2nd Edition, Prentice Hall; 2nd edition (April 1, 1988)
2. Fischer, Zbirka zadataka iz C-a, ETF Osijek (Zavodska skripta), 1999.
3. Richard Heathfield, Lawrence Kirby et al, C Unleashed, SAMS, 2000.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
C11 - ISO/IEC 9899:201x Committee Draft April 12, 2011 N1570, International Organization for Standardization/International Electrotechnical Commission, 2011.	Unlimited (online)	31

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Anita Katić, PhD, Assistant Professor	
Course title	Numerical Mathematics	
Study programme	Graduate university study programme in Electrical Engineering	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30 + (0+15+15)+0

1. COURSE DESCRIPTION

1.1. Course objectives

To explain to students the importance and applications of numerical algorithms and methods. To illustrate how numerical algorithms work using concrete examples, both analytical and computational.

1.2. Course enrolment requirements

Requirements for enrolment in the study programme fulfilled

1.3. Expected learning outcomes

1. Express, calculate and determine errors in numerical methods and draw conclusions about the reasons for these errors.
2. Create a function based on data analysis using approximation and interpolation.
3. Formulate and solve systems of linear or nonlinear equations using methods of numerical mathematics.
4. Create a model for numerical integration problems using practical examples.
5. Develop a model for practical numerical problems with ordinary differential equations and solve them using numerical methods.
6. Create a model for numerical boundary condition problems.

1.4. Course content

Errors. Types of errors. Significant digits of an approximate number. Error of a function. Inverse problem. Interpolation. Spline interpolation. Lagrange interpolation polynomial. Newton interpolation polynomial. Estimation of the interpolation error. Linear interpolation spline. Cubic interpolation spline.
Solving systems of linear equations. Vector and matrix norms. Matrix conditioning. Triangular systems. Matrix decompositions. Iterative methods.
Solving non-linear equations. Bisection method. Method of simple iterations. The Newton method and its modifications. Solving systems of non-linear equations: Newton method, quasi-Newton methods.
Numerical differentiation. Numerical integration. Ordinary differential equations - initial value problem, boundary value problem.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☒ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____

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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), laboratory exercises (LE)	1	1, 2, 3, 4, 5, 6	Attendance at lectures (L), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Preparation for laboratory exercises (LE), results analysis, report writing	1	2, 3, 4, 5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	25
Preparing for an oral exam and oral exam	2	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	25	50
Problem-solving exercises. Design exercises (DE)	1	2, 3, 4, 5	Design exercises (DE)	Evaluation	15	25

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Scitovski, R. Numerička matematika. Osijek: Sveučilište J.J.Strossmayera u Osijeku, Odjel za matematiku, 2015.
2. Chapra, S.C; Canale, R.P. Numerical Methods for Engineers. New York: McGraw-Hill Education, 2015.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. e-skripta: Zlatko Drmač, Vjeran Hari, Miljenko Marušić, Mladen Rogina, Sanja Singer, Saša Singer,

Numerička matematika, Zagreb, 2008. Available at:

http://web.math.pmf.unizg.hr/~singer/num_mat/NM_0910/num_mat1.pdf

2. A. Gilat, Numerical Methods for engineers and scientists, Wiley; 2013

3. A. Kharab, R. Guenther, An Introduction to Numerical Methods, CRC Press; 2021

4. Jaan Kiusalaas, Numerical Methods in Engineering with Python 3, Cambridge University Press, 2013.

5. Jaan Kiusalaas, Numerical Methods in Engineering with MATLAB-Cambridge University Press, 2010.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Scitovski, R. Numerička matematika. Osijek: Sveučilište J.J.Strossmayera u Osijeku, Odjel za matematiku, 2015.	10	15

Chapra, S.C; Canale, R.P. Numerical Methods for Engineers. New York: McGraw-Hill Education, 2015.	4	15
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Davor Vinko, PhD, Associate Professor	
Course title	Microelectronics	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+15+30)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Students should become familiar with the technological foundations for the realisation of microelectronic circuits. To teach the basic skills for designing analogue and digital circuits in the given technology. To introduce students to the creation and management of the project: from the technical requirements, through the design of standard circuits, to the methods of testing the integrated circuit.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Compare the technological principles for the realisation of integrated electronic elements and assemblies. 2. Predict the functioning of basic building blocks of integrated circuits. 3. Design basic analogue integrated electronic circuits. 4. Design basic digital integrated electronic circuits. 5. Evaluate the behavior of CMOS circuits. 6. Select basic CMOS circuits for the realisation of more complex systems. 7. Compare the properties of individual types of CMOS circuits.		
1.4. Course content		
Integrated circuit manufacturing technology: planar silicon technology, thin and thick film hybrid technology. Components of bipolar and unipolar integrated circuits: transistors, diodes, resistors, capacitors. Digital bipolar and unipolar integrated circuits: current switch, basic circuit of the TTL, ECL, I2L, NMOS, CMOS family. Analogue bipolar and unipolar integrated circuits: stages of constant current, reference voltage, stages for shifting the DC voltage level, basic amplification stages, differential amplifier, structures of operational amplifiers. Designing techniques of integrated circuits: PLD, GA, StC, FC. Principles of designing complex microelectronic analogue and digital circuits: amplifiers, comparators, A/D and D/A converters, filters, waveform generators. DFT - methods of incorporating testability into an integrated circuit. Introduction to nanotechnology.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☒ design exercises ☐ working with a supervisor ☐ other _____

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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 5, 6, 7	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Problem-solving exercises	1	3, 4	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Preparation for laboratory exercises (LE), results analysis, report writing	2	5, 6, 7	Design exercises (DE)	Solution evaluation	20	40
Preparing for an oral exam and oral exam	2	1, 2, 3, 4	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Švedek, T. Osnove mikroelektronike
2. Weste, N.H.E; Harris D. CMOS VLSI design - a circuits and systems perspective
3. P. Biljanović Mikroelektronika

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. N. H. E. West, D. Harris CMOS VLSI Design, Third edition
2. A. S.Sedra, K.C.Smith Microelectronic Circuits, 3.Edition

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Švedek, T. Osnove mikroelektronike	10	15
Weste, N.H.E; Harris D. CMOS VLSI design - a circuits and systems perspective	2	15
Biljanović, P. Mikroelektronika	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Mario Vranješ, PhD, Assistant Professor	
Course title	Digital Image and Video Processing	
Study programme	Graduate university study programme in Electrical Engineering, branch Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+0+15+15+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To acquaint students with the features of digital images and video signals. To acquaint students with basic and advanced techniques of processing digital images and video signals and train students for their application in various applications.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled		
1.3. Expected learning outcomes		
1. Recommend relevant parameters for image and video digitization for the selected application 2. Compare the modes of operation of the respective methods for digital image and video processing 3. Evaluate and select suitable pre-processing and image processing methods for the selected application 4. Design a prototype of your own image and video processing algorithm for use in a given application 5. Assess the quality of the created solution for digital image and video processing		
1.4. Course content		
Camera parameters and image digitization. Colour systems, colour subsampling. Procedures for image pre-processing and image manipulation: spatial filtering, noise removal, histogram. Image enhancement methods in the spatial domain. Geometric image transformations. Edge detection, image segmentation and contour detection. Morphological filtering. Image feature extraction. Object detection, motion analysis and object tracking (background subtraction and foreground extraction, optical flow, Kalman filter). 3D scene reconstruction (stereovision). Application in communications, biomedicine, automotive industry and other branches of industry.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☒ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1	1, 2, 3, 4	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	5
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	2, 3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	25
Problem-solving given et design exercises (DE)	2	2, 3, 4, 5	Design exercises (DE)	Evaluating a solution for a given problem	10	20
Preparing for an oral exam	2.5	1, 2, 3, 4, 5	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. S. Birchfield, Image Processing and Analysis, Cengage Learning, 2017

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. P. Jha, B.B. Biswal, OpenCV with Python: A basic approach, 2020.
2. A. Bovik, Handbook of Image and Video Processing, Academic Press, 2000

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
1. S. Birchfield, Image Processing and Analysis, Cengage Learning, 2017	0	

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Snježana Rimac-Drlje, PhD, Full Professor	
Course title	Multimedia Systems	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(0+15+15)+0

1. COURSE DESCRIPTION

1.1. Course objectives

To acquaint students with methods and international standards for multimedia signals encoding and train them for their usage in various applications.

1.2. Course enrolment requirements

Requirements for enrolment in the study programme fulfilled.

1.3. Expected learning outcomes

1. Select the parameters of the image format and video signal format for different applications and determine the necessary bitrates for the transmission of these signals.
2. Relate the features of the human visual system with the performance of individual elements of the still image and video signal compression.
3. Evaluate techniques for removing spatial and temporal redundancy applicable in video signal compression.
4. Choose the parameters of the video signal compression procedure adapted to different types of communication systems.
5. Associate the features of the human speech and audio system with the performance of individual elements for speech and audio signals coding.
6. Select and apply appropriate encoders, protocols and signal parameters for multimedia transmission in various applications.

1.4. Course content

Overview of multimedia applications. Lossless (Run length, Huffman, arithmetic, LZW) and lossy (vector coding, DPCM, DM, ADPCM) compression methods. Transformations for multimedia coding (FFT, DCT, DWT). Basics of human visual perception. Image presentation on the computer; colour systems. Still image coding standards: JPEG and JPEG2000. Digital image formats. Video digitisation, digital video parameters. Techniques for removing spatial and temporal redundancy applicable in video signal compression. Standards for video compression. Video on demand and video streaming. Properties of the speech signal and model of the vocal tract. Algorithms and standards for speech compression. Transmission of voice over IP networks (VoIP). Basics of human audio perception from the aspect of influence on audio compression. Digitisation and coding of audio signals. Multimedia transmission via broadband networks. Multimedia in mobile communications. Quality of Experience (QoE) assessment methods.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☒ design exercises

	☒ distance learning ☐ field work	☐ working with a supervisor ☐ other _____
1.6. Comments	Classes can be held in 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. Monitoring and assessment of student work		
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 student work during classes and in the final exam		

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	3	5
Preparation for laboratory exercises (LE), results analysis, report writing	1	1, 3, 4, 6	Laboratory exercises (LE)	LE preparation evaluation, LE supervision, LE report assessment	10	20
Solving the problem set on DE	2	1, 2, 3, 4, 5, 6	Design exercises (DE)	Evaluating a solution to a given problem	5	25
Preparing for an oral exam and oral exam	2	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Li, Ze-Nian; M. Drew; Mark S., Liu, Jiangchuan, Fundamentals of Multimedia. Springer 2014.
2. S. Rimac-Drlje, M. Vranješ, D. Vranješ: Multimedijski sustavi, priručnik za laboratorijske vježbe, Sveučilište u Osijeku, 2013.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. I.E.G. Richardson: H.264 and MPEG-4 video compression, John Wiley & Sons, 2003.
2. R.C. Gonzales, R.E. Woods: Digital Image Processing, Pearson Prentice Hall, New Jersey, 2008.
3. Jans-Reiner Ohm: Multimedia Signal Coding and Transmission (Signals and Communication Technology), Springer, 2015.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*

Li, Ze-Nian; M. Drew; Mark S., Liu, Jiangchuan, Fundamentals of Multimedia. Springer 2014.	Available as an e-book	25
S. Rimac-Drlje, M. Vranješ, D. Vranješ: Multimedijski sustavi, priručnik za laboratorijske vježbe, Sveučilište u Osijeku, 2013.	25	25
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Slavko Rupčić, PhD, Full Professor	
Course title	Antennas	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Students should be familiarised with the basic parameters of antennas and the methods used to measure them. In addition, students will be introduced to methods for analysing elementary radiation sources and real antennas.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Apply mathematical formulae for analysing and radiating elementary radiation sources. 2. Analyse the radiation of linear dipole and unipole antennas. 3. Conceive, form and design linear and planar antenna arrays for specific purposes. 4. Evaluate different antennas according to performance, parameters and application. 5. Evaluate and select antenna parameters required for the application of antennas in radio communication systems. 6. Plan and evaluate the link budget for the antenna link.		
1.4. Course content		
Antenna parameters: Polarisation, radiation pattern, impedance and intermediate impedance, directivity, gain, effective area (length and width), noise temperature. Basic theorems and their applications. Elementary radiation sources. Approximations in the calculation of fields. Fraunhofer, Fresnel and nearer zone. Linear dipole and unipole antenna. Linear and planar antenna arrays. Calculation of the connection budget for the antenna connection.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
1.6. Comments	Lessons can be held in 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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE)	1	1, 2, 3, 4, 5, 6	Lectures (L), auditory exercises (AE), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	2	5
Problem-solving exercises	3	3, 4, 5	Revision exams (written exam)	Evaluation	15	30
Preparation for laboratory exercises (LE), results analysis, report writing	0.5	3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	20	30
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	18	35

1.10. Obligatory literature (at the time of submitting a study programme proposal)

3. 1. Zentner, E. Antene i radiosustavi. Zagreb: Graphis, 2001.
4. 2. Balanis, C. A. Antenna Theory: Analysis and Design, 4th Edition. Wiley, 2016.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. R. Elliott, Antenna theory and Design, Prentice-Hall, Inc. Englewood Cliffs, N.J, 1981.
2. C.A. Balanis, Antenna Theory – Analysy and Design 3th, John Wiley & Sons, New York, 2005.
3. E. Zentner, Radiokomunikacije, Školska knjiga, Zagreb, 1980.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Zentner, E. Antene i radiosustavi. Zagreb: Graphis, 2001.	1	15
Balanis, C. A. Antenna Theory: Analysis and Design, 4th Edition. Wiley, 2016.	1	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Slavko Rupčić, PhD, Full Professor	
Course title	Optoelectronic Communications	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Students should be familiarised with the basic laws of light propagation in guided and unguided media. Introduction to the basic subsystems of optoelectronic communication systems, modulation and multiplexing methods for optical signals and the architecture of optoelectronic networks.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Evaluate the properties of the different modulation and multiplexing techniques used in optoelectronic communication with the aim of classifying them. 2. Evaluate the properties of different optical transmitters and receivers, taking into account the requirements of the potential system. 3. Evaluate the limitations on the length of the optical fibre link in terms of attenuation, dispersion and non-linear effects. 4. Evaluate the capacity, protective capacity and necessary components for the implementation of an optoelectronic communication system.		
1.4. Course content		
Theory of optical communication. Light propagation in optical fibres - guided optical wave. Optical fibres, non-linearities. Modes and coupling of modes. Suffocation, dispersion, distortion. Theory of optical detection. Optical sources and transmitters. Optical detectors and receivers. Optical amplifiers. Modulation methods in optical communication. Optical systems with multiple channels: WDM, FDM, SCM, OTDM. Optical network technologies.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
1.6. Comments	Lessons can be held in 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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE)	1.2	1, 2, 3, 4	Lectures (L), auditory exercises (AE), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	2	5
Problem-solving exercises	2.3	1, 2, 3, 4	Revision exams (written exam)	Evaluation	15	30
Preparation for laboratory exercises (LE), results analysis, report writing	0.5	1, 2, 3, 4	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	20	30
Preparing for an oral exam and oral exam	1	1, 2, 3, 4	Oral exam	Evaluation	18	35

1.10. Obligatory literature (at the time of submitting a study programme proposal)

5. Blair, S. ECE 5411- Optical Communication Systems. USA: Utah. Edu., notes, 2008.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. R. Ramaswami, Optical Networks, Morgan Kaufman Publishe, INc., 1998.
2. Yariv, Optical Electronics in Modern Communications, Oxford University Press, Eng., 1996.
3. R. Pramod, Optical measurememt Techniques and Applications Norwood ArtechHouse, 1997.
4. M. Cvijetić, Digitalne svjetlovodne komuninkacije, Naučna knjiga, Beograd, 1989.
5. G. P. Agrawal, Fiber-Optic communication Systems, John Wiley & Sons, N.Y.,1997.
6. G. Keiser, Optical Communications Essentials, McGraw Hill, N. Y. 2003.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Blair, S. ECE 5411- Optical Communication Systems. USA: Utah. Edu., notes, 2008.	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Marijan Herceg, PhD, Associate Professor	
Course title	Transmitters	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+15+15+0+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
The objective of this course is to familiarise students with the theoretical fundamentals of oscillators, high-frequency tuned amplifiers, modulators, impedance matching circuits, and enable students to design basic HF circuits.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Design oscillators with negative resistance and positive feedback, and understand the basic principles of their operation. 2. Analyse the electrical conditions in LC and RC oscillator circuits. 3. Understand the structure and operating principles of RF power amplifiers. 4. Design and analyze impedance matching circuits. 5. Understand the basic principles of modulation techniques based on sinusoidal and pulse carrier signals, and evaluate their performance. 6. Understand the structure and operating principles of pulse-code and delta modulation, and design such systems.		
1.4. Course content		
Oscillators. Theory of negative resistance oscillators and feedback oscillators. High-frequency LC oscillators. Low-frequency RC oscillators. Methods for improving the amplitude and frequency stability of oscillators. Crystal quartz oscillators. Frequency synthesis methods: direct and indirect synthesis, phase-locked loop (PLL). High-frequency power amplifiers (class A, B, and C). Frequency multipliers. Sinusoidal signal modulation: amplitude modulation (AM) and angle modulation (FM and PM), structure of modulators and demodulators. Discrete sinusoidal signal modulation: amplitude shift keying (ASK), phase shift keying (PSK), and frequency shift keying (FSK), structure of modulators and demodulators. Pulse signal modulation: pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM), and pulse frequency modulation (PFM), structure of modulators and demodulators. Digital modulation techniques: pulse-code modulation (PCM) and delta modulation (DM), structure of modulators and demodulators.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☐ distance learning	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor

	☐ field work	☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	0.7	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Solving tasks	2.3	2, 4	Control tasks (written exam)	Evaluation of solved tasks	20	40
Preparation for laboratory exercises (LE), results analysis, report writing	1	2, 5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Preparing for an oral exam and oral exam	3	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Grebennikov, Andrei. RF and Microwave Transmitter Design. John Wiley & Sons, Inc., 2011.
2. B.Modlic, I.Modlic, Pojačala snage: serija visokofrekvencijska elektronika, Školska knjiga, Zagreb, 1992.
3. B.Modlic, I.Modlic, Titranje i oscilatori, Školska knjiga, Zagreb, 1993

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. I.Modlic, B.Modlic, Visokofrekvencijska elektronika - Oscilatori, pojačala snage, Školska knjiga, Zagreb, 1982.
2. B.Modlic, I.Modlic, Modulacije i modulatori : serija visokofrekvencijska elektronika, Školska knjiga, Zagreb, 1995.
3. B.Modlic, J. Bartolić, Miješanje, mješala i sintetizatori frekvencije, Školska knjiga, Zagreb, 1995.
4. G. Gonzalez, Foundations of oscillator circuit design, Artech House, 31. pro 2006.
5. Andrei Grebennikov, RF and Microwave Transmitter Design, a John Wiley & Sons, Inc., 2011.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Grebennikov, Andrei. RF and Microwave Transmitter Design. John Wiley & Sons, Inc., 2011.	1	15

B.Modlic, I.Modlic, Pojačala snage: serija visokofrekvencijska elektronika, Školska knjiga, Zagreb, 1992.	2	15
B.Modlic, I.Modlic, Titranje i oscilatori, Školska knjiga, Zagreb, 1993.	3	15
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Tomislav Matić, PhD, Associate Professor	
Course title	Radio-Relay and Satellite Communications	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(30+0+0)+0

1. COURSE DESCRIPTION
1.1. Course objectives
By successfully mastering the course, students will learn about radio relay systems and understand the way RR radio equipment works (MUX, modem, first transmitter). By preparing seminar papers, students will learn about the methodology of designing an RR link and will handle topics from the field of mobile satellite systems, satellite antennas and the use of satellite communications for special purposes - TDRSS. Participants will acquire knowledge in the field of radio diffusion and communication satellites, and special purpose satellites: orbital positioning.
1.2. Course enrolment requirements
Requirements for enrolment in the study programme fulfilled.
1.3. Expected learning outcomes
1. Identify and understand the underlying concepts related to digital radio-relay (RR) and satellite (stationary and mobile) communication systems. 2. Describe and explain the key technical characteristics and parameters of radio equipment (low-noise input amplifier, MUX, output power amplifier, modem, transponder) and characteristics of typical RR and satellite antenna systems . 3. Evaluate the effects of propagation, atmospheric conditions and free space propagation losses on the quality of RR and satellite connection systems. 4. Evaluate and apply planning, reliability and quality of RR and satellite connections in terms of the frequency plan: channel arrangement, interference, parasitic cross-linking and intermodulation products. 5. Evaluate the methods and apply RR design planning procedures: estimation of connectivity of the first Fresnell's zone, calculation of propagation loss on the trail and fading and application of diversity techniques. 6. Evaluate and describe the difference between radio-diffusion, communication satellites and special-purpose satellites with respect to the orbit position, satellite switching, influence of the atmosphere and the noise temperature of a receiver.
1.4. Course content
Examples of radio-relay systems (analogue, digital, low-channel, multi-channel). Distribution of electromagnetic spectrum, planning of RR link. Reliability and quality of connection, reference circuit. Radio RR equipment connection: MUX, modem, first transmitter. Conditions of propagation: atmospheric effects, choking of free space. Antenna RR connection: antenna features, antenna types. Frequency plan: channel planning, interference, transverse-back connection to the back-to-back system, intermodulation products. RR Link Design: Fresnell's zone, budget route, failure, diversity technique. Synchronous digital hierarchy. Radio-diffusion and communication satellites, and special-purpose satellites: orbital accommodation. Technical characteristics and parameters of a communication satellite and terrestrial stations: antennas, low-noise pre-amplifiers, output amplifiers, transponders. Commutation on a satellite. Calculation of up-link and down-link.

Influence of the atmosphere. Receiver temperature of a receiver. Mobile satellite systems. Satellite antenna. Use of satellite communications for special purposes - TDRSS.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☐ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE)	1	1, 2, 3, 4, 5, 6	Lectures (L), auditory exercises (AE)	Attendance tracking. Minimum attendance percentage: 70%.	5	10
Problem-solving exercises	1.5	3, 4, 6	Revision exams (written exam)	Evaluation	15	30
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	20	40
Writing a seminar paper; presenting a seminar paper	1	1, 2, 5, 6	Seminar (S)	Grading a seminar paper; grading a seminar paper presentation	10	20

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Gerard., Maral; Bousquet; Michel ; Sun, Zhili . Satellite Communications Systems: Systems, Techniques and Technology. Wiley, 2009.
2. I.Modlic, B.Modlic, Visokofrekvencijska elektronika - Oscilatori, pojačala snage, Školska knjiga, Zagreb, 1982.
3. I.Modlic, B.Modlic, Visokofrekvencijska elektronika - Modulacija, modulatori, sintezatori frekvencije, Školska knjiga, Zagreb, 1982.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. M.Schwartz, Information, Transmission, Modulation and Noise, McGraw-Hill, 1980.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*

Gerard., Maral; Bousquet; Michel; Sun, Zhili. Satellite Communications Systems: Systems, Techniques and Technology. Wiley, 2009.	1	15
I.Modlic, B. Modlic, Visokofrekvencijska elektronika - Oscilatori, pojačala snage, Školska knjiga, Zagreb, 1982.	17	15
I.Modlic, B. Modlic, Visokofrekvencijska elektronika - Modulacija, modulatori, sintezatori frekvencije, Školska knjiga, Zagreb, 1982.	19	15
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Drago Žagar, PhD, Full Professor, Krešimir Grgić, PhD, Associate Professor	
Course title	Codes and Coding	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To acquaint students with the issue of optimal and protective coding of information. Explain the borderline possibilities to protect information from transmission errors. Present basic and advanced protective techniques coding with the aim of choosing the optimal coding method in the given communication conditions.		
1.2. Course enrolment requirements		
Requirements for enrolment in the first year of study fulfilled.		
1.3. Expected learning outcomes		
1. Construct optimal and security codes for given information transfer conditions. 2. Assess the conditions and limits of secure communication in relation to the capacity of the communication channel and the area of protective coding. 3. Design an encoder and decoder for binary linear security codes. 4. Choose the appropriate security code in accordance with the requirements of the communication environment in terms of efficiency and the expected level of error correction. 5. Apply appropriate programming tools for simulation and analysis of the operation of the protection code in the simulated environment. 6. Recommend an appropriate security code under the given communication conditions.		
1.4. Course content		
Encoding information at the source. Optimal encoding. Basic news coding theorem and understanding of the concept of news set entropy. Possibilities and limitations of information security coding. The capacity of the binary symmetrical channel. Possible and impossible coding area. Burst errors. Interweaving (interleaving). Perfect codes. Application of algebra in information protection. Block codes. Codes with control parity: single-bit parity, cross-priority codes, repeating binary codes, binary codes with repetition and parity. Hamming codes. Binary linear codes. Cyclic codes. Application of shift registers for encoding and decoding of codes. Bose-Chaudhury-Hocquenghem (BCH) code. Peterson-Gorenstein-Zierler decoder. Reed-Solomon codes. Convolutional codes. Viterbi decoder, Turbo codes and properties. LDPCcodes. Coding efficiency. Application of codes in computing and communications.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor

	☐ field work	☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE)	2	1, 2, 3, 4, 5, 6	Lectures (L), auditory exercises (AE), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	1	4
Problem-solving exercises	1.5	1, 2, 3, 4, 5	Revision exams (written exam)	Evaluation	16	32
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	1, 2, 3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	12	24
Preparation and presentation of the seminar paper	0.5	2, 3, 4, 5	Preparation and presentation of the seminar paper	Verification of the content of the seminar work and presentation of the results	6	10
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	15	30

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. I.S. Pandžić et al, Uvod u teoriju informacije i kodiranje, Element Zagreb, 2009.
2. N. Rožić, Informacija i komunikacije, kodiranje s primjenama, Alinea, Zagreb 1992.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. S. Gravano, Introduction to Error Control Codes, Oxford University Press, Oxford, 2001.
2. M. Purser, Introduction to Error-Correcting Codes, Artech House, Boston-London, 1995.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
I.S. Pandžić et al, Uvod u teoriju informacije i kodiranje, Element Zagreb, 2009.	5	15
N. Rožić, Informacija i komunikacije, kodiranje s primjenama, Alinea, Zagreb 1992.	1	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Mario Vranješ, PhD, Assistant Professor	
Course title	Machine Learning	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+0+15+15+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To acquaint students with the principles of data analysis and machine learning methods. To acquaint students with types of machine learning (supervised and unsupervised learning). Train students to develop machine learning models for solving classification and regression problems. Train students to develop solutions for data clustering and data dimensionality reduction data using unsupervised machine learning methods. To familiarize students with the basics of neural networks and deep learning. To enable students to acquire appropriate skills in working with software tools that enable data analysis and machine learning.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Recommend an appropriate model based on machine learning to solve a given problem. 2. Design your own software solution with the application of appropriate libraries with implemented methods and algorithms of machine learning. 3. Evaluate the appropriateness of using a particular method based on supervised and unsupervised learning for a given problem. 4. Evaluate the performance of different machine learning models and choose the most suitable one for the given problem. 5. Combine different methods of unsupervised and supervised machine learning to solve more complex problems.		
1.4. Course content		
Introduction to machine learning. Types of machine learning: supervised learning, unsupervised learning. Regression and classification methods (binary classification, multiclass classification). Complexity of the model. Confusion matrix-based model evaluation metrics (accuracy, precision, recall, sensitivity, F1-measure). Model selection. Preparation of the data set. Different supervised machine learning methods/algorithms: linear regression, polynomial regression, support vector machines, decision trees, random forests. Data clustering, dimensionality reduction and feature extraction. Basics of neural networks. Basics of deep learning. Applications of deep learning in image processing and computer vision. Working with software tools that support machine learning and deep learning.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☒ design exercises

	☒ distance learning ☐ field work	☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1	1, 2, 3, 4, 5	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	5
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	2, 3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	25
Problem-solving given at design exercises (DE)	1.5	2, 3, 4,5	Design exercises (DE)	Evaluating a solution for a given problem	10	20
Preparing for an oral exam	2	1, 2, 3, 4, 5	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. E. Alpaydin, Introduction to Machine Learning, MIT Press, 2014.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. S. Raschka, Python Machine Learning, 3rd Edition, Packt Publishing Ltd., 2019

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
1. E. Alpaydin, Introduction to Machine Learning, MIT Press, 2014	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Emmanuel Karlo Nyarko, PhD, Associate Professor, Damir Filko, PhD, Associate Professor	
Course title	Object-Based Programming	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30 + 0 + 30 + 0 + 0

1. COURSE DESCRIPTION		
1.1. Course objectives		
Familiarise students with the fundamental principles of object-oriented programming, introduce them to the programming languages C# and Python, and present the development of applications with graphical user interfaces.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Develop an object model based on a given problem. 2. Design user-defined class types and create and use objects based on them. 3. Write a program in the C# and/or Python programming language that solves a given problem using an object-oriented design approach. 4. Identify errors in an object-oriented program, correct them, create a correct version, and test the program's functionality according to object-oriented design. 5. Analyse a given problem and independently write computer programs that solve it.		
1.4. Course content		
Fundamental principles of object-oriented programming, differences compared to procedural programming. Programming languages C# and Python. The concept of a class and an object. Variables and methods as part of an object. Class elements and their access control. Basic procedures for creating and destroying an object. Object lifecycle. Polymorphism, list of heterogeneous objects, and virtual functions. Inheritance. Access control over classes: private, protected, and public. Operator overloading. Function and class templates. Exception handling. Templates. Multithreading and multithreaded applications. Events. Development of applications with graphical user interfaces.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
1.6. Comments	Classes can be conducted in 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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), laboratory exercises (LE)	2	1, 2, 3, 4, 5	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	7	10
Preparation for laboratory exercises (LE), results analysis, report writing	1	1, 2, 3, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	30
Project tasks	1	1, 2, 3, 4, 5	Working on project tasks	Review of project task results, presentation evaluation	0	25
Preparing for an oral exam and oral exam	1	1, 2, 3, 4, 5	Oral exam	Evaluation	18	35

1.10. Obligatory literature (at the time of submitting a study programme proposal)

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

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

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

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Lutz, M. Learning Python, 5th Edition. O'Reilly Media, 2013.	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Krešimir Grgić, PhD, Associate Professor	
Course title	Computer Systems Security	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	1	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To acquaint students with security issues in modern computer systems and networks (threats, attacks, risks) and knowledge necessary for planning, designing parameters and implementing modern cryptosystems, security mechanisms and security protocols in computer networks and systems.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled		
1.3. Expected learning outcomes		
1. Analyse, evaluate and apply different types of modern symmetric and asymmetric cryptosystems. 2. Analyse and evaluate existing security threats, attacks and risks in modern computer and communication systems. 3. Implement and apply various security systems and mechanisms intended for modern computer networks. 4. Assess and evaluate various Internet security protocols and standards within computer systems and networks. 5. Analyse security requirements and implement security mechanisms in different types of wireless networks.		
1.4. Course content		
Basic cryptographic terms; Substitution and transposition ciphers; Encryption devices; Examples of symmetric cryptosystems and their application – DES, 3DES, IDEA, RC5, AES, etc.; Linear and differential cryptanalysis; Modes of operation of block ciphers; Concept of public key; Examples of asymmetric cryptosystems and their application - RSA, Diffie-Hellman, ElGamal, DSA, etc.; Cryptographic hash functions; Digital signature; Random number generators; Security policy and risk management; Security threats; Types of malware; Types of attacks and possible countermeasures; Denial of service attacks; Types and configuration of firewalls; Virtual private networks; Intrusion detection and prevention methods; Intrusion detection systems – HIDS, NIDS; Electronic mail security; SSL and TLS; HTTPS; Security of IPv4 and IPv6 protocols – IPsec; Authentication protocols; Safe routing; Security in wireless local area networks; WEP, WPA, WPA2; Security in ad hoc and sensor networks.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____

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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE)	2	1, 2, 3, 4, 5	Lectures (L), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	1	4
Problem-solving exercises	0.5	1, 2, 4	Revision exams (written exam)	Evaluation	16	32
Preparation for laboratory exercises (LE), results analysis, report writing	1	1, 2, 3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	12	24
Preparation and presentation of the seminar paper	0.5	2, 3, 4, 5	Preparation and presentation of the seminar paper	Verification of the content of the seminar work and presentation of the results	6	10
Preparing for an oral exam and oral exam	1	1, 2, 4, 5	Oral exam	Evaluation	15	30

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Dujella, M. Maretić. Kriptografija. Zagreb: Element, 2007.
2. Stallings, M. Cryptography and Network Security - Principles and Practice (7th edition). Boston:Pearson, 2016.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. W. Stallings, Network Security Essentials – Applications and Standards, Prentice Hall, New Jersey, 2013.
2. W. Stallings, Computer Security – Principles and Practice, Prentice Hall, New Jersey, 2011.
3. A. Dujella, M. Maretić, Kriptografija, Element, Zagreb, 2007.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Dujella, M. Maretić. Kriptografija. Zagreb: Element, 2007.	3	15
Stallings, M. Cryptography and Network Security - Principles and Practice (7th edition). Boston:Pearson, 2016.	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Snježana Rimac-Drlje, PhD, Full Professor	
Course title	Mobile Communication Systems	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To acquaint students with the features of radio signal propagation and cellular systems, multiplexing techniques, spread spectrum systems, the multiplexing process of orthogonal frequency sub-carriers as well as with solutions in 2G, 3G, 4G and 5G networks. To train students in applying the acquired knowledge to calculate the signal coverage, traffic load and number of users in a certain cell, the selection of parameters of a certain mobile system, the measurement of characteristic values in the radio access network and the evaluation of the results according to valid standards and regulations.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Choose a model of the radio channel corresponding to the real conditions of propagation. 2. Assess the adequacy of the cellular planning model. 3. Evaluate the properties of different multiplexing techniques with the aim of their classification. 4. Evaluate the properties of various spread spectrum systems. 5. Select and apply the procedure of multiplexing orthogonal frequency carriers in order to improve the transmission characteristics. 6. Compare the architectures of radio mobile networks of different generations. 7. Evaluate and select the characteristics of systems with multiple inputs and multiple outputs to achieve improved transmission characteristics. 8. Select and evaluate different models of MIMO systems and determine the capacity of such systems. 9. Evaluate the results of measuring the parameters of real radio systems.		
1.4. Course content		
Development of mobile communication systems. Mobile radio communication channel; channel models. Propagation characteristics in different conditions, loss calculation, multipath fading, interference, intermodulation, Doppler shift; propagation models. Characteristics of cellular systems; co-channel interference. Macrocells, microcells and picocells. Indoor propagation. Planning of cellular systems. Measures to reduce the distortion of the received signal (transmitter power management, equalisation and diversity). Multiplexing technique: TDMA, FDMA, CDMA. Concept and architecture of GSM-a; GPRS i EDGE. Spread spectrum systems. Concept and architecture of 3G network. Features of OFDM. Access radio and core network of the 4G mobile system (LTE and SAE). Features of Multi-Input and Multi-Output antenna systems (MIMO). Calculation of MIMO system capacity. Features and architecture of 5G networks. Quality of service and end user satisfaction in 4G/5G networks. Features and architecture of local wireless radio networks. Measurement of parameters of real radio systems.		
1.5. Types of classes	☒ lectures	☐ individual exercises

	☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 5, 6, 7, 8, 9	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	3	5
Problem-solving exercises	2	1, 2, 5, 8	Revision exams (written exam)	Evaluation	18	35
Preparation for laboratory exercises (LE), results analysis, report writing	1	1, 5, 8, 9	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	4	10
Preparing for an oral exam and oral exam	2	1, 2, 3, 4, 5, 6, 7, 8	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. A. Bažant i ostali. Osnove arhitekture mreža. Zagreb: Element, 2004.
2. A. F. Molisch, Wireless Communications, 2nd edition. John Wiley&Sons, 2010.
3. S. Ahmadi: LTE –Advanced, Elsevier, 2014.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. M. J. Hernando, F. Perez-Fontan, Introduction to Mobile Communications Engineering, Artech House, 1999.
2. S. Rimac-Drlje, Mobilne komunikacije, priručnik za laboratorijske vježbe, zavodska skripta, 2020.
3. E. Zentner, Antene i radiosustavi, Školska knjiga, Zagreb, 2001.
4. E. Dahlman, S. Parkvall, J. Skold, 5G NR: The Next Generation Wireless Access Technology, Academic Press, 2018
5. A. R. Mishra, Fundamentals of Network Planning and Optimisation 2G/3G/4G: Evolution to 5G, Wiley, 2018.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Bažant, A i ostali. Osnove arhitekture mreža. Zagreb: Element, 2004.	1	25
Molisch, A. F. Wireless Communications, 2nd edition. John Wiley&Sons, 2010.	1	25
S. Ahmadi: LTE –Advanced, Elsevier, 2014.	1	25
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Slavko Rupčić, PhD, Full Professor	
Course title	Receivers	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To familiarise students with the basic parameters of analogue, digital and optical receivers. Demonstrate the basic procedures for analysing the operation of these receivers and the measurement procedures carried out on the receivers.		
1.2. Course enrolment requirements		
Requirements for enrolment in the study programme fulfilled.		
1.3. Expected learning outcomes		
1. Analyse the basic phenomena of the propagation of radio waves and optical signals. 2. Select, analyse and evaluate simple antenna types for use in radio communication systems. 3. Apply channel modelling to evaluate the quality of radio communication. 4. Evaluate the properties of different analogue and digital transmitters and receivers from the point of view of all the requirements of a given system. 5. Evaluate the properties of different optical transmitters and receivers taking into account the requirements of the potential system.		
1.4. Course content		
Characteristics of radio receivers: input characteristics, gain, sensitivity, noise factor, selectivity, dynamic range, unwanted harmonics, frequency stability and accuracy, output characteristics. Analogue heterodyne radio receivers for AM and FM signals (mono, stereo): RF amplifiers, oscillators, mixers, MF amplifiers, demodulators. Digital receivers, structure and subsystems. Receivers in optoelectronic communication.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor ☐ other _____
1.6. Comments	Lessons can be held in 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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE)	1	1, 2, 3, 4, 5	Lectures (L), auditory exercises (AE), laboratory exercises (LE),	Attendance tracking. Minimum attendance percentage: 70%.	2	5
Problem-solving exercises	2	2, 3, 4, 5	Revision exams (written exam)	Evaluation	15	30
Preparation for laboratory exercises (LE), results analysis, report writing	2.5	2, 3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	25
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 4, 5	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. M. Gregurić, Radioprijemna tehnika, Školska knjiga, Zagreb, 1994.
2. H. Meyr, Digital Communications Receivers, Wiley, 1997.
3. B. Silvello, Coherent Optical Communication Systems, Eugenio lanonne, 1994.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Rouphael, T. J. Wireless Receivers Architectures and Design. Elsevier Inc., 2015.
2. M. Schwartz, Information transmission, modulatiom and noise, McGraw-Hill, New York, 1980.
3. I. Zahradka, Radiokomunikacijski sustavi, Školska knjiga, Zagreb, 1994.
4. J. Budin, Optičke komunikacije, Univerza v Ljubljani, Ljubljana, 1993.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
M. Gregurić, Radioprijemna tehnika, Školska knjiga, Zagreb, 1994.	6	15
H. Meyr, Digital Communications Receivers, Wiley, 1997.	1	15
B. Silvello, Coherent Optical Communication Systems, Eugenio lanonne, 1994.	1	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Davor Vinko, PhD, Associate Professor	
Course title	Application of Microcontroller Systems	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	7
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	15+(0+30+15)+0

1. COURSE DESCRIPTION

1.1. Course objectives

To familiarise students with the architecture and operation of microcontrollers. To provide students with practical knowledge of working with AVR microcontrollers. To explain to students the process of designing a system based on a microcontroller and to show how to combine the program code and the circuit part into a functional unit.

1.2. Course enrolment requirements

Requirements for enrolment in the second year of study fulfilled.

1.3. Expected learning outcomes

1. Select the elements and architecture of the embedded computer system.
2. Design the firmware according to the application requirements.
3. Design the circuits of the embedded computer system.
4. Analyse the requirements for the realization of the circuit and firmware for embedded computer systems.
5. Design the architecture of complex software solutions for embedded computer systems.
6. Integrate firmware and circuitry into a functional unit.

1.4. Course content

General information about microcontroller systems, difference between microcomputer and microcontroller, RISC architecture, popular solutions: AVR, PIC, Freescale. Programming languages and compilers used: Arduino, C++, BASCOM, ASSEMBLER, Atmel Studio. Design flow: writing code, compiling, setting fuse and lock bits, programming a hex file. Characteristics of the C programming language when used in microcontrollers: working with pointers, bit operations, variables. Communication with microcontroller systems: RS232, I2C, 1Wire. AVR microcontroller architecture, registers, input/output interfaces: Current and voltage limits. Oscillators: internal RC, quartz. Analogue-to-digital conversion, timing circuits, comparator. Memory: Flash, EEPROM, SRAM. Working with interrupt routines, sleep modes, programming modes. Adding sensors and execution elements. Measurement of DC and AC quantities: voltage, current, power. Management of high-power loads (high and low frequency pulse width modulation - PWM), PCB design, assembly, testing. Project planning.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☒ design exercises ☐ working with a supervisor ☐ other _____

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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Problem-solving exercises	1	2, 3, 4	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Preparation for laboratory exercises (LE), results analysis, report writing	2	4, 5, 6	Design exercises (DE)	Solution evaluation	20	40
Preparing for an oral exam and oral exam	2	1, 2, 3	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Muhammad Ali Mazidi; Sarmad Naimi, Sepehr Naimi AVR Microcontroller and Embedded Systems: Using Assembly and C

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Dhananjay V. Gadre, Nehil Malhotra tinyAVR Microcontroller Projects for the Evil Genius

2. John Catsoulis Designing Embedded Hardware

3. Atmel 8-bit AVR Microcontroller with 16K Bytes In-System Programmable Flash – technical specifications

4. Richard H. Barnett, Larry O Cull, Sarah Cox Embedded C Programming and the Atmel AVR

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Muhammad Ali Mazidi; Sarmad Naimi, Sepehr Naimi AVR Microcontroller and Embedded Systems: Using Assembly and C	2	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Snježana Rimac-Drlje, PhD, Full Professor	
Course title	Digital Video Technique	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+30+15)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To acquaint students with the features of television systems and the application of standards for video encoding in digital television. To train students for the independent development of software support for digital television receivers, which includes handling the hardware of the television receiver, development of middle layer software support, use of protocols in digital television and downloading and use of data from the transport stream, as well as the design of a basic television application.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Evaluate techniques for removing spatial and temporal redundancy applicable in video signal compression. 2. Evaluate the application of different standards in video coding. 3. Evaluate source and channel coding, and types of modulation in DVB-T and DVB-T2. 4. Compare different ways of content protection and conditional access to content in digital television. 5. Develop software support for a digital television receiver, including the use of protocols as well as download and use of data from the transport stream. 6. Design of basic television applications.		
1.4. Course content		
Analogue television systems. Digitisation of component and composite video signals. Temporal and spatial correlation. Techniques for removing spatial and temporal redundancy during video signal compression (motion estimation and compensation, motion vector calculation, texture coding). Entropy coding. Application of MPEG-2, H.264/AVC and H.265 standards in digital television. Video quality assessment. Overview of standards for digital television. DVB-T and DVB-T2 (source and channel coding, modulation). Single frequency networks. Organization of program and transmission streams. MPEG-2 transport stream, signaling information and organization of the process of delivering audio, video and data streams to the receiver. Hardware architecture and software for DTV receivers. Content protection, conditional access to content through DVB-CSA, DVB-CI and CI+ standards. Hardware architectures and software for systems with conditional access.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☒ design exercises ☐ working with a supervisor

		☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.5	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	3	5
Preparation for laboratory exercises (LE), results analysis, report writing	0.5	5	Laboratory exercises (LE)	LE preparation evaluation, LE supervision, LE report assessment	4	10
Solving the problem set on DE	1	6	Design exercises (DE)	Evaluating a solution to a given problem	15	30
Preparation of documentation for the project	0.5	5, 6	Design exercises (DE)	Documentation quality check	10	15
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 4	Oral exam	Evaluation	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1.M. Bjelica, N. Teslić, V. Mihić, Softver u digitalnoj televiziji, Tehnički univerzitet Fakultet tehničkih nauka, Novi Sad, 2017.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. Walter Fischer: Digital Video and Audio Broadcasting Technology, A Practical Engineering Guide (Signals and Communication Technology), 4th Edition, Springer, 2020.
2. E.G. Richardson: H.264 and MPEG-4 video compression, John Wiley & Sons, 2003.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
M. Bjelica, N. Teslić, V. Mihić, Softver u digitalnoj televiziji, Tehnički univerzitet Fakultet tehničkih nauka, Novi Sad, 2017.	4	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Josip Balen, PhD, Associate Professor	
Course title	Intelligent Transportation Systems	
Study programme	Graduate university study programme in Electrical Engineering, branches: Communication Technologies and Network Technologies	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+0+30+0+0

1. COURSE DESCRIPTION

1.1. Course objectives

Introduce students with the area of intelligent transport systems with an emphasis on wireless ad-hoc vehicle networks - VANETs (Vehicular Ad-hoc Networks). Train students to develop, implement and evaluate algorithms for efficient information dissemination between vehicles and infrastructure in wireless ad-hoc vehicle networks.

1.2. Course enrolment requirements

Requirements for enrolment in the first year of study fulfilled.

1.3. Expected learning outcomes

1. Explain the basic concepts, methods and challenges in intelligent transport systems.
2. Explain the advantages of new technologies built into vehicles and transport infrastructure
3. Evaluate the properties of different network topologies.
4. Evaluate and select different routing techniques and protocols with the aim of achieving the required characteristics in the selected network.
5. Evaluate the properties of different network architectures with regard to the used protocols and addressing principles with the aim of their classification.
6. Develop and programmatically implement algorithms for effective message propagation in wireless ad-hoc vehicle networks.
7. Perform algorithm testing using traffic simulator and traffic communication simulator.
8. Implement and evaluate your own solution to a given complex project task.
9. Evaluate management mechanisms and protocols in modern communication networks.
10. Document your own solution to a given complex project task through the creation of a technical report, scientific paper or presentation materials.

1.4. Course content

Introduction to basic principles and challenges in intelligent transport systems. Intelligent roads, industrial spaces and transport infrastructure. Overview of new technologies embedded in vehicles and robots (architecture, embedded systems, operating systems, communication devices). Autonomous vehicles without drivers in outdoor and indoor spaces. Efficient information sharing in wireless vehicles networks (applications and concepts). Security of communication, vehicles and people. Algorithms and protocols for efficient information dissemination between vehicles. Simulations of traffic and communication between vehicles and infrastructure by using Omnet++, Veins i SUMO simulators. Processing of obtained results and evaluation of performance.

1.5. Types of classes	☒ lectures	☒ individual exercises

	☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☒ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	0.5	1, 2, 3, 4, 5, 6, 7, 8	Lectures (L), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	7	10
Preparation for laboratory exercises (LE), results analysis, report writing	1	5, 6, 7, 8	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	6	15
Preparing for an oral exam and oral exam	1	1, 2, 3, 4	Oral exam	Evaluation	12	25
Work on a project assignment	2.5	1, 2, 3, 4, 5, 6, 7, 8	Group project work	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Dr. Fei Hu, Vehicle-to-Vehicle and Vehicle-to-Infrastructure Communications: A Technical Approach, CRC Press; 1 edition, 2018.
2. C. Sommer, F. Dressler, Vehicular Networking, Cambridge University Press, 2014.
3. J. Balen, Učinkovito rasprostiranje poruka u mrežama vozila zasnovano na njihovom položaju, doktorska disertacija, Osijek, Elektrotehnički fakultet, 2014.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. By Sonali P. Botkar, Sachin P. Godse, Parikshit N. Mahalle, Gitanjali R. Shinde, VANET Challenges and Opportunities, CRC Press, 2021.
2. M. Picone, S. Busanelli, M. Amoretti, F. Zanichelli, G. Ferrari, Advanced Technologies for Intelligent Transportation Systems, Springer, 2014.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course		
Title	*Number of copies*	*Number of students*
Dr. Fei Hu, Vehicle-to-Vehicle and Vehicle-to-Infrastructure Communications: A Technical Approach, CRC Press; 1 edition, 2018.	1	12
C. Sommer, F. Dressler, Vehicular Networking, Cambridge University Press, 2014.	1	12
J. Balen, Učinkovito rasprostiranje poruka u mrežama vozila zasnovano na njihovom položaju, doktorska disertacija, Osijek, Elektrotehnički fakultet, 2014.	1	12
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Ivanka Ferčec, MA, Senior Lecturer, Yvonne Liermann-Zeljak, MA, Senior Lecturer	
Course title	German	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+30+0+0+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
According to level A1 of the Common European Framework of Reference for Languages (basic user), teach students how to: - formulate and use familiar everyday expressions and very basic phrases aimed at the satisfaction of needs of a concrete type, introduce oneself and others, - ask and answer questions about themselves and others (e.g. where they live, people they know, and things they possess), - interact with other people in a simple way (provided the other person talks slowly and clearly and is prepared to help).		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Relate fundamental concepts used in everyday private and business environments that are thematically related to the topics. 2. Formulate (daily) activities in private and business environments that are thematically related to the topics, and identify and compare the rules of Croatian and German. 3. Integrate newly acquired knowledge of grammar and present the acquired structures in written and spoken communication. 4. Link simpler statements and sentences into more complex ones. 5. Write simple and short texts thematically related to the content covered in the course.		
1.4. Course content		
Begrüssung, Befinden, Angaben zur Person, Famile, Einkaufen, Möbel, Büro und Technik, Freizeit, Essen, Reisen, Verkehrsmittel, Tagesablauf, Vergangenes. Personalpronomen, Possessivartikel, definiter und indefiniter Artikel, Negativartikel, Zahlen, Präsens, W-Fragen, Ja/Nein Fragen, trennbare und untrennbare Verben, Perfekt mit *sein* und *haben*, Modalverben *können*, *mögen*. Uhrzeiten, Tageszeiten, Wochentage. Jahreszeiten, Monate. Präpositionen.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning	☒ individual exercises ☒ multimedia and network ☐ laboratory exercises ☐ design exercises ☐ working with a supervisor

	☐ field work	☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L) and auditory exercises (AE)	1.4	1, 2, 3, 4, 5	Lectures (L), auditory exercises (AE)	Attendance tracking. Minimum attendance percentage: 70%	0	0
Homework	0.7	1, 2, 3, 4, 5	Grammar exercises/Short texts on a given topic	Oral evaluation of solved exercises/Correcting written assignments	0	5
Active class participation	0.7	1, 2, 3, 4, 5	Self-initiated class participation through the application of linguistic and grammatical structures covered in the course	Recording self-initiated class participation /Evaluation of given answers	0	5
Problem-solving exercises	1.2	1, 2, 3, 4, 5	Continuous assessment (revision exams, written exam)	Evaluation of solved exercises	25	50
Preparing for an oral exam and oral exam	1.0	1, 2, 3, 4	Oral exam	Evaluation of given answers	20	40

1.10. Obligatory literature (at the time of submitting a study programme proposal)

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

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

M. Reimann, *Grundstufen - Grammatik für Deutsch als Fremdsprache*, Max Hueber Verlag, Ismaning, 1996.

R. Luscher, *Übungsgrammatik für Anfänger*, Max Hueber Verlag, Ismaning, 2001.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
S. Evans, A. Pude, F. Specht, *Menschen* (A 1.1) - Kursbuch, Hueber Verlag GmbH&Co KG, Ismaning, 2012.	10	15

S. Glas-Peters, A. Pude, M. Reimann, *Menschen* (A 1.1) - Arbeitsbuch, Hueber Verlag GmbH&Co KG, Ismaning, 2012.	10	15
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Ratko Grbić, PhD, Associate Professor, Josip Job, PhD, Associate Professor	
Course title	Internet of Things	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30 + (0 + 15 + 15) + 0

1. COURSE DESCRIPTION

1.1. Course objectives

To familiarise students with basic theoretical knowledge and practical skills in the field of the Internet of Things and to prepare them for both independent and collaborative project work involving data collection, storage, processing, and visualisation, aligned with the Internet of Things paradigm.

1.2. Course enrolment requirements

Requirements for enrolment in the second year of study fulfilled.

1.3. Expected learning outcomes

1. Assess and justify the suitability of the elements of the given IoT system.
2. Assess the suitability of tools for the development of the microcontroller program code in a specific project.
3. Create your own software solution based on several suitable libraries for the use of sensors in the microcontroller based system.
4. Propose the design of an Internet of Things system for a given simple problem.
5. Integrate software support and circuitry into the functional system of the Internet of Things.
6. Design the architecture of software solutions for Internet of Things systems.

1.4. Course content

Introduction to the Internet of Things (IoT). IoT technologies (elements, circuits, communication, platforms and development environments). IoT architecture and infrastructure. Circuit-based objects. Data acquisition and storage(methods, protocols, applications and services). Data Access. User interfaces and Presentation of Data. Security in IoT systems. Application of the Internet of Things: industry, meteorology, agriculture, medicine, smart houses, smart cities.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☒ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	1.4	1, 2, 3, 4, 5, 6	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	0
Preparation for laboratory exercises (LE), results analysis, report writing	0.6	1, 2, 3, 4, 5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	10	20
Problem-solving exercises	1	1, 2, 3, 4, 5, 6	Design exercises (DE)	Project evaluation	20	30
Preparing for an oral exam and oral exam	2	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	20	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Gary Smart, Practical Python Programming for IoT: Build advanced IoT projects using a Raspberry Pi 4, MQTT, RESTful APIs, WebSockets, and Python 3, Packt Publishing, 2020.
2. Bahga, A; Madisetti V. Internet of Things: A Hands-on-Approach, Arshdeep Bahga & Vijay Madisetti, 2014.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

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.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
1. Gary Smart, Practical Python Programming for IoT: Build advanced IoT projects using a Raspberry Pi 4, MQTT, RESTful APIs, WebSockets, and Python 3, Packt Publishing, 2020.	2	15
2. Bahga, A; Madisetti V. Internet of Things: A Hands-on-Approach, Arshdeep Bahga & Vijay Madisetti, 2014.	1	15

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Drago Žagar, PhD, Full Professor, Krešimir Grgić, PhD, Associate Professor	
Course title	Communication Protocols	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To acquaint students with the methods and procedures of development of communication protocols. Explain the basics and application of Petri nets in the development of communication protocols. Explain the protocol mechanisms for control and signaling in communication networks.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Identify methods and tools for formal specification, verification and testing of communication protocols. 2. Analyse communication protocols and processes in the network. 3. Plan tools and methods for the analysis and synthesis of communication protocols. 4. Apply different models for protocol description and analysis. 5. Choose the appropriate method for protocol specification and verification. 6. Evaluate management mechanisms and protocols in modern communication networks.		
1.4. Course content		
Architecture of communication networks. Protocols and protocol architecture. Structured protocol development. Phases of protocol development. Formal and semi-formal methods. Protocol specification. Protocol verification. Implementation of the protocol. Protocol evaluation. State perturbation method. Tools for analysis and synthesis of communication protocols. Structure and performance of Petri nets. Modeling communication protocols with a Petri net. Petri net modeling of calls and services. SPIN and Promela. Protocol simulators. A layered approach to protocol development. OSI model. Hierarchical approach, DoD model. Local networks and protocols. Routing protocols. Reservation protocols, RSVP protocol for resource reservation. IP protocol and networking. IPv6 protocol, possibilities and issues of introducing the new protocol. Control protocols. Transport protocols. Application protocols. Protocols in mobile networks. Signaling protocols. Signaling for call processing and service functions. Conceptual model of an intelligent network. CAS (R2), CCS. SS7 protocol stack and OSI model. H.248, BICC, SIP-T, SIP-I. Protocol for starting the session. Protocol for the description of the SDP session. Network management protocols.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☒ auditory exercises ☒ distance learning	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor

	☐ field work	☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE)	2.5	1, 2, 3, 4, 5, 6	Lectures (L), auditory exercises (AE), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	1	4
Problem-solving exercises	0.5	2, 4, 5, 6	Revision exams (written exam)	Evaluation	16	32
Preparation for laboratory exercises (LE), results analysis, report writing	1.5	2, 3, 4, 5, 6	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	12	24
Preparation and presentation of the seminar paper	0.5	3, 4, 5, 6	Preparation and presentation of the seminar paper	Verification of the content of the seminar work and presentation of the results	6	10
Preparing for an oral exam and oral exam	1	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	15	30

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. Lovrek, I. Modeli telekomunikacijskih procesa - teorija i primjena Petrijeve mreže. Zagreb: Školska knjiga, 1997.
2. Tanenbaum, A. S.; Feamster, N.;Wetherall, D. J., Computer Networks - 6. izdanje. Pearson, Boston, 2021.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. A. Bažant, et al, Osnovne arhitekture mreža, Element Zagreb, 2014.

2. W. Stallings, Data and Computer Communications, Tenth Edition, Macmillan Publishing Company, New York, 2014.

3. Gerard J. Holzmann, Design and Validation of Computer Protocols, Prantice Hall, New Jersey, 1991.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*

Lovrek, I. Modeli telekomunikacijskih procesa - teorija i primjena Petrijeve mreže. Zagreb: Školska knjiga, 1997.	2	15
Tanenbaum, A. S.; Feamster, N.;Wetherall, D. J., Computer Networks - 6. izdanje. Pearson, Boston, 2021.	1	15
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Snježana Rimac-Drlje, PhD Full Professor	
Course title	Mobile Communications	
Study programme	Graduate university study programme in Electrical Engineering, branch Communications and Informatics	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	6
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	45+(15+15+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To acquaint students with the features of radio signal propagation in mobile communications, features of cellular systems and solutions in 2G, 3G, 4G and 5G networks. To train students in applying the acquired knowledge to calculate the signal coverage and traffic load in a certain cell, to select parameters of a certain mobile system, for the measurement of characteristic values in the radio access network and the evaluation of the results according to valid standards and regulations.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Choose a model of the radio channel corresponding to the real conditions of propagation. 2. Assess the adequacy of the cellular planning model. 3. Evaluate the properties of different multiplexing techniques with the aim of their classification. 4. Select and apply the procedure of multiplexing the orthogonal frequency carriers in order to improve the transmission characteristics. 5. Compare the architectures of radio mobile networks of different generations. 6. Select and evaluate different models of MIMO systems and determine the capacity of such systems. 7. Evaluate the results of measuring the parameters of real radio systems.		
1.4. Course content		
Development of mobile communication systems. Mobile radio communication channel; channel models. Propagation characteristics in different conditions, loss calculation, multipath fading, interference, intermodulation, Doppler shift; propagation models. Characteristics of cellular systems; co-channel interference. Macrocells, microcells and picocells. Indoor propagation. Planning of cellular systems. Measures to reduce the distortion of the received signal (transmitter power management, equalization and diversity). Concept and architecture of GSM. Physical and logical channels, call establishment, transmission power control, modulation and coding, call handover. GPRS and EDGE. Concept and architecture of UMTS (3G) network. Features of OFDM. Access radio and core network of the 4G mobile system (LTE and SAE). MIMO antenna systems. Features and architecture of 5G networks. Quality of service and end user satisfaction in 4G/5G networks. Features and architecture of local wireless radio networks. Measurement of parameters of real radio systems.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises

	☒ auditory exercises ☒ distance learning ☐ field work	☐ design exercises ☐ working with a supervisor ☐ other _____

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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), auditory exercises (AE), laboratory exercises (LE), design exercises (DE)	2	1, 2, 3, 4, 5, 6, 7	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	3	5
Problem-solving exercises	1.5	1, 2, 4, 6	Revision exams (written exam)	Evaluation	18	35
Preparation for laboratory exercises (LE), results analysis, report writing	1	1, 4, 6, 7	Laboratory exercises (LE)	LE preparation evaluation, LE supervision, LE report assessment	4	10
Preparing for an oral exam and oral exam	1.5	1, 2, 3, 4, 5, 6	Oral exam	Evaluation	25	50

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. A. Bažant i ostali. Osnove arhitekture mreža. Zagreb: Element, 2004.
2. A. F. Molisch, Wireless Communications, 2nd edition. John Wiley&Sons, 2010.
3. S. Ahmadi: LTE –Advanced, Elsevier, 2014.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

1. M. J. Hernando, F. Perez-Fontan, Introduction to Mobile Communications Engineering, Artech House, 1999.
2. S. Rimac-Drlje, Mobilne komunikacije, priručnik za laboratorijske vježbe, zavodska skripta, 2020.
3. E. Zentner, Antene i radiosustavi, Školska knjiga, Zagreb, 2001.
4. E. Dahlman, S. Parkvall, J. Skold, 5G NR: The Next Generation Wireless Access Technology, Academic Press, 2018
5. A. R. Mishra, Fundamentals of Network Planning and Optimisation 2G/3G/4G: Evolution to 5G, Wiley, 2018.

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Bažant, A i ostali. Osnove arhitekture mreža. Zagreb: Element, 2004.	2	25

Molisch, A. F. Wireless Communications, 2nd edition. John Wiley&Sons, 2010.	1	25
S. Ahmadi: LTE –Advanced, Elsevier, 2014.	1	25
1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences		
Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.		

General information		
Lead instructor(s)	Marijan Herceg, PhD, Associate Professor, Ratko Grbić, PhD, Associate Professor	
Course title	Linux in Embedded Systems	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Compulsory	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	4
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+15+15)+0

1. COURSE DESCRIPTION

1.1. Course objectives

The aim of the course is to familiarise students with the structure and functioning of the Linux operating system and the customisation of the Linux kernel for various platforms. The course will enable students to independently design and develop software components of the Linux operating system kernel, with a special emphasis on its use in embedded computer systems.

1.2. Course enrolment requirements

Requirements for enrolment in the second year of study fulfilled.

1.3. Expected learning outcomes

1. Configure, build, and run the Linux operating system on a specific computer platform.
2. Create software components for the Linux operating system kernel.
3. Integrate software support and hardware into a functional unit for a Linux-based computer system.
4. Manage memory and access hardware components.
5. Combine debugging techniques in the development of Linux kernel components.

1.4. Course content

Introduction to the Linux kernel. Kernel source code. Configuration, compilation, and booting of the Linux kernel. Bootloader. Device tree. Linux root filesystem. Linux kernel modules. Character device driver. Linux device model. Kernel frameworks for drivers. Memory management and hardware access. Processes, scheduling, resource waiting, interrupt handling, and locking. Linux kernel debugging techniques. Customisation of the Linux kernel for a targeted embedded computer platform.

1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning ☐ field work	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☒ design exercises ☐ working with a supervisor ☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), laboratory exercises (LE), design exercises (DE)	1.5	1, 2, 3, 4, 5	Lectures (L), laboratory exercises (LE), design exercises (DE)	Attendance tracking. Minimum attendance percentage: 70%.	0	5
Preparation for laboratory exercises (LE), results analysis, report writing	1	2, 3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	15	30
Solving problems assigned in design exercises	0.5	2, 3, 4, 5	Design exercises (DE)	Evaluation of the solution for the given problem	15	30
Preparing for an oral exam and oral exam	1	1, 2, 3, 4, 5	Oral exam	Evaluation	18	35

1.10. Obligatory literature (at the time of submitting a study programme proposal)

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

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

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

1.12. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
Sam Siewert, John Pratt: Real-Time Embedded Components and Systems with Linux and RTOS, Mercury Learning & Information, 2016.	1	14
Doug Abbott: Linux for Embedded and Real-time Applications, Edition 3, Newnes, 2012.	1	14

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

General information		
Lead instructor(s)	Damir Blažević, PhD, Associate Professor, Krešimir Grgić, PhD, Associate Professor	
Course title	Computer Networks Design	
Study programme	Graduate university study programme in Electrical Engineering, branch: Communications and Informatics	
Course status	Elective	
Year of study	2	
ECTS credits and teaching methods	ECTS credits	5
	Number of classes (lectures + auditory exercises + laboratory exercises + design exercises + seminars)	30+(0+30+0)+0

1. COURSE DESCRIPTION		
1.1. Course objectives		
To provide participants with practical knowledge in the field of computer networks design. Through lectures and exercises, train them to analyse user needs, design, project, configure, implement, analyse and eliminate irregularities in the operation of the computer network. To acquaint the participants with legal and technical regulations in the field of design and construction. Special emphasis should be placed on the creation of project documentation, cost sheets, configuration files of network devices (special purpose computers), their implementation and maintenance. Acquaint the participants with a practical approach to the implementation of service quality in a specific network environment.		
1.2. Course enrolment requirements		
Requirements for enrolment in the second year of study fulfilled.		
1.3. Expected learning outcomes		
1. Recognise and describe problems in the management of modern computer networks. 2. Demonstrate the creation of LAN communication cables, create and verify the correctness of a simple and extended LAN network by network layers, use a network traffic analyser, explain the results. 3. Calculate and select the address scheme of IP addresses and masks for an arbitrarily given network. 4. Plan and design a local computer network, choose, justify and recommend the selection of passive and active network equipment. 5. Create a configuration file for the network device (switch and router) according to the given conditions, perform implementation on the network device and analyse the operation of the device. 6. Classify and categorise types of network traffic, create and test lists for filtering network traffic, propose QoS settings.		
1.4. Course content		
Introduction to legal and technical regulations related to the design of computer networks. Creation of project documentation. Computer networks. Types and division of computer networks. Passive and active network devices. Computer hardware and software. Creation of configuration files for network nodes. Computer network design, equipment specification, construction and maintenance. Implementation of quality of service settings. Creation of access lists.		
1.5. Types of classes	☒ lectures ☐ seminars and workshops ☐ auditory exercises ☒ distance learning	☐ individual exercises ☐ multimedia and network ☒ laboratory exercises ☐ design exercises ☐ working with a supervisor

	☐ field work	☐ other _____
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. Monitoring and assessment of student work

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 student work during classes and in the final exam

STUDENT ACTIVITY	ECTS	LEARNING OUTCOME	TEACHING METHOD	ASSESSMENT METHOD	POINTS	
					Min	Max
Attendance at lectures (L), laboratory exercises (LE)	1	1, 4, 6	Lectures (L), laboratory exercises (LE)	Attendance tracking. Minimum attendance percentage: 70%.	4	10
Preparation for laboratory exercises (LE), results analysis, report writing	1	2, 3, 4, 5	Laboratory exercises (LE)	Preparation for LE, LE supervision, LE report assessment	8	15
Preparing for an oral exam and oral exam	1	1, 4, 6	Oral exam	Evaluation	18	35
Colloquiums	1	2, 3	Colloquiums	Evaluation	8	20
Seminar work	1	1	Work in pairs	Evaluation and presentation	0	20

1.10. Obligatory literature (at the time of submitting a study programme proposal)

1. A. S. Tanenbaum, Computer Networks, 5th ed., Pearson 2014.
2. M. Radovan, Računalne mreže 1, Digital Point Tiskara, Rijeka 2010.
3. M. Radovan, Računalne mreže 2, Digital Point Tiskara, Rijeka 2011.

1.11. Recommended additional literature (at the time of submitting a study programme proposal)

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. Number of obligatory literature copies in relation to the number of students currently taking the course

Title	*Number of copies*	*Number of students*
A. S. Tanenbaum, Computer Networks, 5th ed., Pearson 2014.	1	10
M. Radovan, Računalne mreže 1, Digital Point Tiskara, Rijeka 2010.	2	10
M. Radovan, Računalne mreže 2, Digital Point Tiskara, Rijeka 2011.	2	10

1.13. Quality assurance methods ensuring the acquisition of knowledge, skills and competences

Conducting a university survey on teachers (teacher availability during office hours, quality of teaching materials on course websites, clarity and comprehensibility of lectures, fairness and transparency in grading) and conducting a Faculty survey on learning outcomes and ECTS credits.

5.4. Student evaluation criteria

OKVIRI KRITERIJA OCJENJIVANJA STUDENATA FERIT-a

U Tablici 1 su prikazane moguće aktivnosti tijekom semestra, „pragovi", preporučeni udio pojedinačne aktivnosti u ukupnom broju bodova ostvarivih tijekom semestra i sl. Za svaki predmet potrebno je uz praćenje pohađanja nastave provoditi još najmanje dvije aktivnosti. Ako je za aktivnost potreban broj bodova/postotak naveden u obliku „od-do", nositelj predmeta za svoj predmet treba za tu aktivnost odrediti točno potreban broj bodova/postotak unutar tog raspona.

Ako studenti ne ostvare minimalno potreban uspjeh iz svih aktivnosti da bi se one smatrale uspješno položenim, tj. ako ne ostvare „pragove" iz svih aktivnosti, nemaju pravo prijaviti ispit, nego trebaju nadoknaditi aktivnost.

Ako student dobrovoljno želi neku aktivnost izvršavati ponovno sljedeće ak. godine, onda se podrazumijeva da niti jedna aktivnost na predmetu nije uspješno položena, tj. student mora ponovno polagati sve aktivnosti na predmetu. Studentu koji ponovno izvršava aktivnosti, predmetni nastavnik može u potpunosti ili djelomično priznati uspješno odrađene aktivnosti u prethodnoj godini (npr. uspješno pohađanje nastave ili bodove iz LV) te student ima pravo ponovno pristupiti kontrolnim zadaćama i u tom slučaju student je dužan na početku akademske godine nastavniku najaviti dolaske na kontrolne zadaće.

Ako je trajanje uspješno položene aktivnosti i/ili bodova vezano uz ispitni rok, onda to znači da je vezano za jedan ispitni termin u slučaju izvanrednih ispitnih rokova, odnosno za najviše oba ispitna termina redovitog ispitnog roka (zimski, ljetni, jesenski). Iznimno, ako se održava izvanredni ispitni rok u rujnu, onda uspješno položene aktivnosti i/ili bodovi u jesenskom roku obuhvaćaju i taj izvanredni ispitni rok.

Ukupan broj bodova (UBB) i konačna ocjena određuju se prema Tablici 2.

Za sve studente vrijede oni kriteriji koji su vrijedili pri prvom upisu predmeta. Ako student pri ponavljanju predmeta izvršava ponovno sve aktivnosti, tada za studenta vrijede oni kriteriji koji su definirani za ak. godini u kojoj student ponavlja predmet.

Studenti u statusu „dovršetka studija" po razini opterećenja jednaki su redovitim studentima, te se stoga na njih odnose sve odredbe na isti način kao i na redovite studente.

Pod terminom nastave smatra se razdoblje od najmanje jednog školskog sata istog oblika nastave iz istog predmeta tijekom kojeg nastavnik evidentira nazočnost studenata.

Studentu koji ometa izvođenje nastave nastavnika i/ili praćenje nastave ostalih studenata, odnosno izvođenje provjere znanja, nastavnik ima pravo poništiti evidentiranu nazočnost u dotičnom terminu, odnosno evidentirati za termin neopravdani izostanak, te ga uputiti da napusti prostoriju. Usto prema sveučilišnom „Pravilniku o stegovnoj odgovornosti studenata" nastavnik ima pravo studenta prijaviti za ometanje izvođenja nastave ili provjere znanja, odnosno za nedolično ponašanje prema nastavnicima, studentima i zaposlenicima.

Tablica 1. Moguće aktivnosti tijekom semestra, „pragovi", preporučeni udio pojedinačne aktivnosti u ukupnom broju bodova ostvarivih tijekom semestra i sl.

Moguće aktivnosti tijekom semestra	Maksimum bodova po uspješno položenoj aktivnosti (nastavnik određuje maksimum unutar dolje navedenog raspona)	Minimalno potreban uspjeh iz aktivnosti da bi se smatrala uspješno položenom („prag")		Trajanje uspješno položene aktivnosti[1]	Trajanje bodova iz aktivnosti[2]	Nadoknada u slučaju neuspješno položene aktivnosti	Maksimalan zbroj bodova ostvarenih tijekom semestra mora biti fiksan za predmet, i to u rasponu od 40 do 70 bodova (v. Tablicu 2) ∑⇒
Pohađanje nastave (PR+AV+ +KV+LV)	od 0 do 10	Ukupno (PR+AV+KV+LV) minimalno 70% nazočnosti[3,4,5].		Trajno	Do početka sljedećeg ciklusa nastave iz predmeta	Potrebno sljedeće ak. godine ponovno pohađati nastavu[6]	
LV/KV[7]	od 0 do 30	100 % kolokviranih vježbi				Moguće za do 30% vježbi[8]	
Domaće zadaće	od 0 do 30	0 % do 50 % bodova				Moguće za do 20% bodova[h]	
Seminarski rad	od 0 do 30						
Dodatne aktivnosti[9]	od 0 do 30						
Kontrolne zadaće[10]	od 0 do 50	Iz svake pojedinačno	Od 20 % do 50 %	Prvi sljedeći ispitni rok		Pismeni ispit (v. redak ispod za detalje)	
		Kumulativno	50 %				
Pismeni ispit[11]	Jednako broju bodova za aktivnost „Kontrolne zadaće" [12]	50 %[13]		Na tekućem ispitnom roku			

[1] Za vrijeme navedenog trajanja se smatra da je aktivnost uspješno položena (pa i u slučaju da je isteklo vrijeme „trajanja bodova iz aktivnosti", v. sljedeću fusnotu).

[2] Za vrijeme navedenog trajanja se računaju bodovi ostvareni iz aktivnosti . odnosno nakon isteka navedenog trajanja se bodovi izjednačavaju sa nulom, ali se aktivnost i dalje smatra uspješno položenom sve dok ne istekne vrijeme „trajanja uspješno položene aktivnosti" (v. prethodnu fusnotu).

[3] Navedeni prag se ne odnosi na izvanredne studente. Na polaznike Razlikovnih obveza odnosi se postotak definiran za svaki pojedinačni predmet, a koji može biti manji od 70%. Za predmete s konzultativnim izvođenjem obavezan je dolazak na barem pet termina konzultacija.

[4] Ovo je ujedno prag i za potpis u indeks (ovjera „urednog izvršavanja obveza").

[5] Za PR, i isto tako AV, nastavnik ne može tražiti više od 70% nazočnosti.

[6] U slučaju opravdanog izostanka s nastave, nastavnik studentu može odobriti nadoknadu: PR i AV (moguće do 50% sati) u obliku veće angažiranosti na nekoj od ostalih aktivnosti ili na nekoj dodatnoj aktivnosti, za LV i KV (moguće do 30% vježbi) kako je opisano pod fusnotom „h".

[7] Obavezno provoditi ako u izvedbenom planu postoje laboratorijske ili konstrukcijske vježbe. Kolokviranje LV/KV podrazumijeva sljedeće: napisana/popunjena priprema za svaku vježbu, uspješno odrađena svaka vježba, napisan/popunjen izvještaj za svaku vježbu, uspješno položene provjere znanja iz izvještaja (prag za provjere znanja iznosi 50%). Studenti ne mogu nadoknaditi vježbe na kojima nisu bili nazočni iz neopravdanih razloga. Nenapisana/nepopunjena priprema se smatra jednakom neopravdanom izostanku s vježbi, tj. student nema pravo prisustvovati vježbi, te taj izostanak može nadoknaditi tek sljedeće ak. godine. Neuspješna provjera znanja iz priprema, odnosno netočno popunjena/napisana priprema smatra se jednakom opravdanom izostanku s vježbi, tj. student nema pravo prisustvovati vježbi, ali može nadoknaditi vježbu.

[8] Potrebno nadoknaditi najkasnije prije početka prvog sljedećeg ispitnog roka (iznimno, ako je riječ o nekoj od specifičnih dodatnih aktivnosti, npr. praktični rad u laboratoriju, projektni zadatak, i sl., nastavnik može studentima odobriti duži rok za nadoknadu ako za to postoje opravdani razlozi). Neuspješna nadoknada ili veći iznos nadoknade može se odraditi tijekom sljedećeg ciklusa nastave iz predmeta. Pritom se odrađuju samo neizvršeni dijelovi aktivnosti (npr. ponovno se odrađuju samo neodrađene LV/KV, popravlja se prethodno započeti seminarski rad, itd.).

[9] Dodatne aktivnosti mogu biti grupni zadaci na predavanjima, studentske prezentacije, praktični rad u laboratoriju, projektni zadaci i sl.

[10] Obavezno provoditi ako u izvedbenom planu postoje auditorne vježbe kao oblik provođenja nastave. Tijekom semestra se organiziraju po dvije kontrolne zadaće. Kod ove neuspješno odrađene aktivnosti student iznimno ima pravo prijave ispita kako bi mogao pristupiti pismenom ispitu kao nadoknadi za ovu aktivnost.

[11] Pismeni ispit nije aktivnost tijekom semestra, nego je nadoknada za nepoložene kontrolne zadaće. Student može pristupiti pismenom ispitu jedino ako je uspješno položio ostale aktivnosti.

[12] Nakon uspješno položenog pismenog ispita i završnog usmenog ispita, pod aktivnost kontrolnih zadaća evidentira se broj bodova ostvarenih na pismenom ispitu.

[13] Nositelj predmeta na početku ak. godine definira je li pismeni ispit eliminacijski, tj. smije li student pristupiti usmenom dijelu ispita i ako nije uspješno položio pismeni ispit. Ako student ispit polaže pred ispitnim povjerenstvom (8. izlazak ili prigovor na ocjenu), povjerenstvo pregledava pismeni ispit koji ne mora biti eliminacijski, ali se od studenta u svakom

Tablica 2. Utvrđivanje ukupnog broja bodova (UBB) i konačne ocjene

Zbroj bodova ostvarenih tijekom semestra $\sum\Rightarrow$	od 40 do 70 bodova	Zbroj bodova ostvarenih tijekom semestra i bodova na završnom usmenom ispitu $\sum\Rightarrow$	Ukupan broj bodova (UBB)	Utvrđivanje ocjene na temelju UBB $\Rightarrow$	UBB	Konačna ocjena
			100 bodova		90≤UBB≤100	izvrstan (5)
					75≤UBB<90	vrlo dobar (4)
Završni usmeni ispit[14]	od 60 do 30 bodova				60≤UBB<75	dobar (3)
					UBB<60	dovoljan (2)

NAPOMENE VEZANE UZ PROVJERE ZNANJA I IZVEDBENI PLAN:

- kontrolne zadaće se trebaju realizirati unutar ukupno 16, odnosno 32 sata nastave za AV sa 15, odnosno 30 sati prema izv. planu. To povećanje satnice je moguće samo ako ga je nastavnik najavio satničarima najkasnije nakon odrađenih 8, odnosno 16 sati AV. Tijekom semestra se organiziraju po dvije kontrolne zadaće u trajanju od 45 do 60 minuta za predmete sa 15 sati AV, odnosno u trajanju od 60 do 90 minuta za predmete sa 30 sati AV.
- nadoknade LV/KV sa 15, odnosno 30 sati trebaju se realizirati unutar najviše 16, odnosno 32 sata nastave. To povećanje satnice je moguće samo ako ga je nastavnik najavio satničarima najkasnije nakon odrađenih 50% satnice. Ako je to povećanje nedovoljno za nadoknade, nadoknada se može provesti u obliku provjere znanja iz priprema i izvještaja iz nekolokviranih vježbi u terminima koje je nastavnik dogovorio s pojedinačnim studentima.
- provjere znanja iz LV/KV (iz priprema i izvještaja) trebaju biti provedene tijekom termina LV/KV (npr. na početku ili na kraju svakog pojedinačnog termina) ili u posebnim terminima. Pritom satnica posebnih termina ne ulazi u izvedbeni plan niti se računa pod realizacijom izvedbenog plana. Za posebne termine će satničari osigurati mjesto u rasporedu pod uvjetom da nositelj predmeta na početku ak. godine najavi održavanje posebnih termina za provjeru znanja iz LV/KV i navede trajanje svakog termina.
- budući da nisu obavezni, kolokviji (vezani za usmeni ispit) realiziraju se izvan satnice predviđene izvedbenim planom, tj. ta satnica ne ulazi u izvedbeni plan niti se računa pod realizacijom izvedbenog plana. Pritom će satničari osigurati potrebne termine i objaviti ih u rasporedu pod uvjetom da nositelj predmeta na početku ak. godine najavi održavanje dva kolokvija tijekom semestra i navede trajanje svakog kolokvija.

slučaju očekuje i da na usmenoj provjeri znanja pokaže i znanje koje je bilo potrebno za uspješno polaganje pismenog dijela ispita.

[14] Ispitni prag na završnom usmenom ispitu iznosi 50% uspješnosti na završnom usmenom ispitu. Završni usmeni ispit se može održati i u obliku dva kolokvija tijekom semestra (prag za svaki pojedinačni iznosi od 20% do 50%, kumulativno 50%). Uspješno položeni kolokviji vrijede prvi sljedeći ispitni rok. Pritom, u slučaju da je student na jednom kolokviju imao uspješnost najmanje 50%, ali kumulativno manje od 50%, nastavnik može odobriti studentu da na usmenom ispitu odgovara parcijalno, tj. samo tematske cjeline nepoloženog kolokvija.
Za usmeni ispit (odnosno kolokvije tijekom semestra) ispitivač treba definirati u prosjeku 2 do 5 ispitnih pitanja za svaki sat predavanja. Ispitivač nije dužan ispitivati strogo prema ispitnim pitanjima, odnosno ispitna pitanja služe kao smjernice studentima za pripremu za usmeni ispit (odnosno kolokvije tijekom semestra).