|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Zaščita in vodenje elektroenergetskih sistemov | | | | | | | | | | | | | | |
| **Course title:** | | | Power System Protection and Control | | | | | | | | | | | | | | |
|  | | | | |  | | | | | | | |  | |  | | |
| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Podiplomski magistrski študijski program druge stopnje Elektrotehnika | | | | | Elektroenergetika | | | | | | | | 2 | | 1 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | Electrical Power Engineering | | | | | | | | 2 | | 1 | | |
|  | | | | | | | | | | | | | | | | | |
| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni-strokovni / Compulsory professional | | | | | |
|  | | | | | | | | | | | |  | | | | | |
| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64284 | | | | | |
|  | | | | | | | | | | | | | | | | | |
| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| 45 |  | | | 30 | | |  | | | |  | | | 75 | |  | 6 |
|  | | | | | | | | | | | | | | | | | |
| **Nosilec predmeta / Lecturer:** | | | | | Miloš Pantoš | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski in po potrebi angleški / Sloveneian and English, if necessary | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski in po potrebi angleški / Sloveneian and English, if necessary | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik predmeta | | | | | | | | |  | Enrolment in the year of the course | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Sekundarni elektroenergetski sistem, lastnosti zaščitnega sistema, redundanca, osnovne karakteristike relejev, instrumentni transformatorji, zaščita generatorjev, zaščita transformatorjev, zaščita zbiralk, zaščita vodov, digitalna zaščita, sistemska zaščita.  Elementi vodenja, podatkovna omrežja, obdelava podatkov, komunikacijske povezave, avtomatizacija v elektroenergetiki, regulacije v elektroenergetskem sistemu, funkcije vodenja (vodenje omrežja, vodenje proizvodnje, nadzor sigurnosti sistema, simulator, ostale funkcije vodenja), organizacija vodenja (nivoji vodenja, konfiguracija in struktura sistema vodenja, povezava s sistemom vzdrževanja), standardi in protokoli, oprema sistema vodenja. | | | | | | | |  | | Protection and control equipment in power systems, power system protection principles, redundancy, features of protective relays, current and voltage transformers, protection of generators, transformers, lines, numerical (digital) protection, wide area protection.  Elements of power system control, databases, SCADA systems, communication, signal processing, automation of power systems, frequency and voltage regulation, control functions (network, production, consumption, reliability of supply, simulator, other control functions), control management (control levels – OSI model, configuration of control systems, control and maintenance), standards and protocols, control equipment. | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Horowitz S.H., Phadke A.G., Power system relaying, J. Wiley & Sons, New York, 1992. 2. Ogorelec A., Gubina F., Osnove vodenja elektroenergetskega sistema, Založba FE, Ljubl,jana, 1981 3. Kundur P., Power System Stability and Control, McGraw-Hill, 1993 4. Anderson P. M., Fuad A. A., Power System Control and Stability, IEEE Press, New York, 1994 5. M. Pantoš et al., Zaščita elektroenergetskih sistemov, knjiga v pripravi. 6. M. Pantoš:et al., Vodenje elektroenergetskih sistemov, knjiga v pripravi. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Študentje si bodo ustvarili celostno sliko o delovanju sekundarnih elektroenergetskih sistemov s poudarkom na sistemih zaščite in vodenja. Spoznali bodo osnovne fizikalne principe delovanja zaščitnih naprav, razvoj zaščitne tehnike in sistemov vodenja, avtomatizacije, načinov ščitenja posameznih elementov in delov elektroenergetskega sistema v okviru sistemske zaščite. Spoznali bodo vlogo instrumentnih transformatorjev, pomen redundance pri zaščiti, funkcije vodenja, vlogo in razvoj podatkovnih omrežij, obdelavo podatkov, komunikacijske povezave, standarde in protokole. | |  | | Students will become familiar with basic principles in the field of power system protection and control, basic physical principles of different phenomena in power systems, development of technologies in the field of protection and automation, protective solutions of different elements, wide area protection systems, the role of measurement transformers (current and voltage), protection redundancy, control functions, databases, signal processing, communication technologies, standards and protocols. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Znanje in razumevanje:  Študent bo razumel koncepte ščitenja elementov elektroenergetskega sistema in delovanja sistema vodenja elektroenergetskega sistema. Pridobljeno znanje bo študent sposoben nadgraditi v praksi.  Uporaba:  Širši pregled na področju zaščite in vodenja elektroenergetskega sistema, zaščite posameznih elementov, funkcij vodenja v centru vodenja, vloge zaščitnih sistemov in sistemov vodenja pri zagotavljanju zanesljive oskrbe z električno energijo in varnim obratovanjem.  Prenosljive spretnosti:  Sposobnost sodelovanja pri vzpostavljanju zaščitnih sistemov in sistemov vodenja ter avtomatizacije. | | |  | Knowledge and understanding:  Students will understand concepts of power system protection and control functions. The obtained knowledge will be upgradable in the practice.  Application:  Review in the field of power system protection, control and automation, protection of power system elements (generator, transformer, power line etc.), control functions in control rooms, the role of protection, control and automation in the field of reliable supply and safety in power system operation.  Transferable skills:  Ability to participate in conceptualization and realization of protective and control systems and automation of power systems. | |
|  | | |  |  | |
| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja in vaje za utrjevanje pridobljenega znanja. | | |  | Lectures and exercises. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: laboratorijske vaje, pisni izpit, ustni izpit.  Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne.  Pozitivna ocena vaj je pogoj za pristop k izpitu.  Prispevki k oceni:  laboratorijske vaje  pisni izpit  ustni izpit | 50%  25%  25% | | | | Type: laboratory exercises, written exam, oral exam.  Negative grades: from 1 to 5, positive grades: from 6 to 10.  Positive evaluation of laboratory exercises is a prerequisite for the exam.  Contributions to final grade:  laboratory exercises  written exam  oral examination |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. TERZIJA, Vladimir, STANOJEVIĆ, Vladimir, PANTOŠ, Miloš. Overhead lines protection based on synchronized phasors technology, Proceedings of the 15th International Conference on Power System Protection - PSP 2006, Bled, Slovenia, September 6-8, 2006, str. 11-19.  2. GANTAR, Janez, VERBIČ, Gregor, PANTOŠ, Miloš. Tele frequency relay protection, Proceedings of the 15th International Conference on Power System Protection - PSP 2006, Bled, Slovenia, September 6-8, 2006, str. 123-127.  3. ŠMON, Ivan, PANTOŠ, Miloš, GUBINA, Ferdinand. An improved voltage-collapse protection algorithm based on local phasors. Electric power systems research, 2008, vol. 78, no. 3, str. 434-440.  4. PIRNAT, Blaž, PANTOŠ, Miloš. Comparison of basic protection algorithms, Proceedings of the 15th International Conference on Power System Protection - PSP 2006, Bled, Slovenia, September 6-8, 2006, str. 178-183.  5. VERBIČ, Gregor, PANTOŠ, Miloš, GANTAR, Janez. A novel principle for measuring overfrequency and frequency rate of change, Proceedings of the 15th International Conference on Power System Protection - PSP 2006, Bled, Slovenia, September 6-8, 2006, str. 184-189. | | | | | |