|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Kakovost električne energije | | | | | | | | | | | | | | |
| **Course title:** | | | Power Quality | | | | | | | | | | | | | | |
|  | | | | |  | | | | | | | |  | |  | | |
| **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:** | | | | | | | | | | | | 64285 | | | | | |
|  | | | | | | | | | | | | | | | | | |
| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| 45 |  | | | 30 | | |  | | | |  | | | 75 | |  | 6 |
|  | | | | | | | | | | | | | | | | | |
| **Nosilec predmeta / Lecturer:** | | | | | Igor Papič | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | | |
| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski/Slovenian | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski/ Slovenian | | | | | | | | | | | |
| **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):** | | | | | | | |
| Splošno o kakovosti električne energije, osnovni pojmi in definicije, pregled standardov. Prehodni pojavi, dolgotrajna odstopanja napetosti, kratkotrajna odstopanja napetosti, napetostno neravnotežje. Popačenje oblike; enosmerne komponenete, harmoniki, med-harmoniki. Kolebanje napetosti - fliker. Napetostni upadi in prekinitve. Kazalci prekinitev napajanja.  Izvajanje občasnih in trajnih meritev parametrov kakovosti električne energije, modeliranje delov omrežja in bremen za analizo kakovosti, sistemske impedančne karakteristike. Metode za porazdelitev odgovornosti za kakovost električne energije na sistemsko in porabniško stran. Širjenje motenj po omrežju.  Ukrepi za izboljšanje kakovosti električne energije. | | | | | | | |  | | Introduction to power quality, basic terms and definitions, overview of power quality standards. Transient phenomena, long term voltage deviations, short term voltage deviations, voltage unbalance. Waveform distortions; dc components, harmonics, interharmonics. Voltage fluctuations – flicker. Voltage sags and interruptions. Supply interruption indices.  Measurements of power quality parameters, permanent monitoring systems. Modelling of parts of power networks and loads for power quality analysis; system impedance characteristics. Methods of sharing responsibility for power quality distortion between network and customer side. Spreading disturbances across the network.  Measures for power quality improvement. | | | | | | | |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Dougan, R.C., McGranaghan, M.F., Wayne Beaty, H., Electrical Power Systems Quality, McGraw-Hill, 1996. 2. Blume, D., Schlabbach, J., Stephanblome, T., Spannungsqualität in elektrischen Netzen, VDE-Verlag, 1999. 3. Bollen, M.H.J., Understanding Power Quality Problems – Voltage Sags and Interruptions, IEEE, 2000. 4. Arrillaga, J., Smith, B.C., Watson, N.R., Wood, A.R., Power System Harmonic Analysis, Wiley, 2000. 5. Arrillaga, J., Watson, N.R., Chen, S., Power System Quality Assessment, Wiley, 2001. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Študent bo poznal osnovne pojme kakovosti električne energije in značilnosti napajalne napetosti. Pridobil bo osnovno znanje o izvedbi meritev, analizi merilnih rezultatov parametrov kakovosti napetosti in možnih ukrepih za izboljšanje kakovosti napajanja. | |  | | The student will acquire the knowledge of basic power quality terms and supply voltage characteristics and will also improve their knowledge of measurement performance, analysis of measurement results of power quality parameters, and possible measures to improve power quality. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Znanje in razumevanje:  Študent bo razumel pomen kakovost električne energije pri obratovanju elektroenergetskega omrežja in oskrbi odjemalcev. Poznal bo glavne parametre kakovosti napetosti in metode za odpravo motenj.  Uporaba:  Predznanje za nadaljevanje študija in uporaba v praksi pri izvedbi meritev in analizi kakovosti električne energije.  Refleksija:  Razumevanje povezave med kakovostjo oskrbe, načrtovanjem kompenzacije in posledicami slabe kakovosti oskrbe.  Prenosljive spretnosti:  Znanje o postopku izvedbe meritev in analizi merilnih rezultatov je splošno uporabno pri izvajanju različnih meritev. | | |  | Knowledge and understanding:  Students will understand the importance of power quality for the operation of power networks and customer supply. Students will also learn about the main parameters of voltage quality and compensation methods.  Application:  Prerequisites for further study, and practical application of measurements and power quality analysis.  Reflection:  Understanding the connection between the quality of supply, compensation planning and consequences of poor quality of supply.  Transferable skills:  Knowledge of measurement procedure and analysis of measurement results is useful in the frame of various measurements. | |
|  | | |  |  | |
| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, avditorne vaje, laboratorijske vaje. | | |  | Lectures, tutorials and laboratory practice. | |
| **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 laboratorijskih vaj je pogoj za pristop k izpitu.  Prispevki k oceni:  laboratorijske vaje  pisni izpit  ustni izpit | 34%  33%  33% | | | | 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. HERMAN, Leopold, PAPIČ, Igor, BLAŽIČ, Boštjan. A proportional-resonant current controller for selective harmonic compensation in a hybrid active power filter. IEEE transactions on power delivery, Oct. 2014, vol. 29, no. 5, str. 2055-2065. 2. MAKSIĆ, Miloš, PAPIČ, Igor. Calculating flicker propagation in a meshed high voltage network with interharmonics and representative voltage samples. International journal of electrical power & energy systems, Nov. 2012, vol. 42, no. 1, str. 179-187. 3. BOŽIČEK, Ambrož, BLAŽIČ, Boštjan, PAPIČ, Igor. Performance evaluation of a time-optimal current controller for a voltage-source converter and comparison with a hysteresis controller. IEEE transactions on power delivery, 2011, vol. 26, no. 2, str. 859-868. 4. BOŽIČEK, Ambrož, BLAŽIČ, Boštjan, PAPIČ, Igor. Time optimal current control with constant switching frequency for STATCOM. Electric power systems research, 2010, vol. 80, no. 8, str. 925-934. 5. 5. MAKSIĆ, Miloš, PAPIČ, Igor. The calculation of flicker propagation in part of the Slovenian transmission network. International journal of electrical power&energy systems, 2010, vol. 32, no. 9, str. 1037-1048. | | | | | |