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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Optoelektronika | | | | | | | | | | | | | | |
| **Course title:** | | | Optoelectronics | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Univerzitetni študijski program prve stopnje Elektrotehnika | | | | | Elektronika in ostale smeri | | | | | | | | 3. | | zimski | | |
| 1st cycle academic study programme of Electrical Engineering | | | | | Electronics and other study tracks | | | | | | | | 3. | | winter | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | strokovni predmet, obvezen za smer Elektronika in izbirni za ostale smeri /  professional course, compulsory for the study track Electronics and elective for other study tracks | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64127 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **30** | **0** | | | **30** | | | **0** | | | | **0** | | | **65** | |  | **5** |
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| **Nosilec predmeta / Lecturer:** | | | | | Janez Krč | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski / Slovenian  (foreign students – condensed lectures and consultations in English) | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski / Slovenian  (foreign students - consultations in English) | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik. | | | | | | | | |  | Enrolment in the year of the course. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| UVOD: izzivi in trendi v optoelektroniki  SVETLOBA: ponovitev modelov svetlobe, razširjanje, svetloba in snov, kompleksni lomni količnik, odboj, lom, sipanje, barvni prostori  OPTIČNI VIRI: nastanek svetlobe v snovi in pregled sodobnih optičnih virov  - Svetleče diode (LED): direktni polprevodniki, spontana emisija, LED strukture, tehnologija, optične in električne karakteristike, primer krmilnih vezij, organske LED (OLED)  - Laserji: princip laserskega delovanja, stimulirana emisija, zgradba plinskega laserja, optično ojačenje in izgube, spekter in oblika žarka, uporaba laserjev  - Laserske diode (LD): strukture (PN, DH, DBR, DFB, VCSEL), delovanje, praktični primeri uporabe  DETEKTORJI SVETLOBE: detekcija svetlobe v polprevodniku, polprevodniški fotodetektorji (pn, pin, hetero, PD s plazovito ionizacijo, fototranzistor), vezja s fotodetektorji  osnove delovanja in strukture CCD, CMOS, večja a-Si:H detektorska polja  ZASLONI: zgradba in delovanje LCD, LED. plazemskih in OLED zaslonov, principi delovanja 3D zaslonov  OPTIČNA VLAKNA: princip prenosa svetlobe po vlaknu, razlika eno in mnogorodovna vlakna, slabljenje, disperzija, nelinearni efekti  FOTOVOLTAIKA: trendi, sončni spekter, sevanje, obsevanje, delovanje in parametri sončne celice, tehnologije in tipi sončnih celic in fotonapetostnih modulov, fotonapetostni sistemi, načrtovanje sončne elektrarne, primeri izvedbe  Iz omenjenih področij študenti izvedejo 6 laboratorijskih vaj, med njimi eno izbirno v raziskovalnem Laboratoriju za fotovoltaiko in optoelektroniko. | | | | | | | |  | | INTRODUCTION: challenges and trends in Optoelectronics  LIGHT: short revision of models of light, propagation, light and matter, complex refractive index, reflection, refraction, scattering, colour spaces  OPTICAL SOURCES: generation of light, overview of optical sources  - Light emitting diodes (LED): direct semiconductors, spontaneous emission, LED structures, technology, optical and electrical characteristics, examples of driver circuits, organic LED (OLEDs)  - Lasers: operational principle, stimulated emission, main parts of a laser, optical amplification and losses, spectrum and shape of the output beam, applications of lasers  - Laser diodes: structures, PN, DH, DBR, DFB VCSEL LD, applications  PHOTODETECTORS: detection of light in semiconductor, semiconductor photodetectors (pn, pin, heterodiode, avalance, phototransistor), circuits with photodetectors, operational principles and structures of CCD, CMOS and a-Si:H detector arrays  DISPLAYS: structure and operation of LCD, LED, plasma and OLED displays, 3D displays  OPTICAL FIBERS: guiding light in a fiber, single and multimode fibers, attenuation, dispersion, non-linear effects  PHOTOVOLTAICS: trends, solar spectrum, radiation and irradiation, how a solar cell work, technologies of solar cells and photovoltaics modules, photovoltaic systems, steps design of a solar power plant, examples  6 tasks are conducted from the above mentioned topics within the practice work of the course. One of them is elective and is carried out in the research Laboratory of Photovoltaics and Optoelectronics. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. J. Krč, Prosojnice predavanj/ Slides of lectures, dopolnjujejo se vsako leto – dostopne na e-FE/ update each year, available on e-FE  2. S. O. Kasap, Optoelectronics and Photonics – principles and practices, 2nd Ed. Pearson Education, 2013  3. A. Luque, S. Hegedus, Handbook of photovoltaic science and engineering, Wiley, 2011.  4. B. E. A. Saleh, Fundamentals of photonics, Wiley, 2007. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| - osvojiti principe delovanja  obravnavanih optoelektronskih  elementov  - poznavanje sodobnih struktur in  tehnologij optoelektronskih elementov   * pridobljena znanja za praktično uporabo optoelektronskih   elementov v vezjih in sistemih | |  | | * to acquire the knowledge on operational principles of contemporary optoelectronic devices * knowledge on state-of-the-art structures of optoelectronic devices and technologies * knowledge on practical usage of optoelectronic devices in circuits and systems | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Po uspešno opravljenih obveznostih predmeta naj bi študenti poznali osnove delovanja obravnavanih optoelektronskih elementov in bi jih bili sposobni uporabiti v praksi. Bili naj bi motivirani za nadaljnje samostojno delo in uporabo optoelektronskih gradnikov . | | |  | On successful completion of the course students should know operational principles of the analysed devices, being capable to use them in practical work. They should be motivated for future autonomous work in the field of Optoelectronics. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| * predavanja (prosojnice, tabla, interakcija s študenti), * laboratorijske vaje (praktično delo z optoelektronskimi elementi, pred izpitom reševanje izbranih računskih problemov) | | |  | * lectures (slides, blackboard, interaction with students) * laboratory assignments (hands on, before written examination different problems are solved together) | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: pisni izpit in ustni izpit  Končno oceno izpita določata pisni in ustni izpit v deležu, ki je opredeljen v sosednjem stolpcu.  Dodatni pogoji pri načinu ocenjevanja:   * za pozitivno končno oceno mora študentka/študent pozitivno opraviti in pisni in ustni izpit * za pristop k ustnemu izpitu je potrebno pozitivno opraviti pisni izpit in hkrati uspešno opraviti vse laboratorijske vaje predmeta.   Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne. | 40 % pisni /  written exam  60 % ustni /  oral exam | | | | Type: written exam, oral exam.  The final grade is determined based on the results of written exam and oral exam. The share of each contribution is defined in previous column.  Additional conditions:   * a condition for positive final grade is positive grade ofwritten exam and positive grade of oral exam * to take an oral exam there are two conditions: positive grade of the written exam and successfully finished all laboratory assignments   Negative grades: from 1 to 5, positive grades: from 6 to 10. |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. KRČ, Janez, TOPIČ, Marko*. Optical modeling and simulation of thin-film photovoltaic devices*. New York: CRC Press, 2013. 2. KRČ, Janez, SEVER, Martin, TOPIČ, Marko. The two approaches of surface-texture optimization in thin-film silicon solar cells. *IEEE journal of photovoltaics*, ISSN 2156-3381, Oct. 2013, vol. 3, no. 4, str. 1156-1162. 3. KRČ, Janez, LIPOVŠEK, Benjamin, TOPIČ, Marko. Design for high out-coupling efficiency of white OLED using CROWM - a combined geometric/wave optics model. V: *Optical Nanostructures and Advanced Materials for Photovoltaics (2013)*. [S. l.]: The Optical Society, cop. 2014. 4. KRČ, Janez, SEVER, Martin, ČAMPA, Andrej, STELTENPOOL, Mark, MOULIN, Etienne, ERVEN, Rob van, HAUG, Franz-Josef, BALLIF, Christophe, TOPIČ, Marko. Design of advanced surface-textures for thin-film silicon micromorph solar cells. V: Photovoltaic Science and Engineering Conference, October 28 - November 1, 2013, Taipei, Taiwan. *PVCES-23 : technical digest*. [S. l.: s. n.], 2013, str. 1-4. 5. KRČ, Janez, LIPOVŠEK, Benjamin, TOPIČ, Marko. Light management in thin-film solar cell. V: LÓPEZ, Ana Belén Cristóbal (ur.), VEGA, Antonio Martí (ur.), LÓPEZ, Antonio Luque (ur.). *Next generation of photovoltaics : new concepts*, (Springer series in optical sciences, ISSN 0342-4111, 165). Berlin; Heidelberg: Springer, cop. 2012, str. 95-129. | | | | | |