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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Optične komunikacije | | | | | | | | | | | | | | |
| **Course title:** | | | Optical communications | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Podiplomski magistrski študijski program druge stopnje Elektrotehnika | | | | | Telekomunikacije | | | | | | | | 1 | | 2 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | Telecommunications | | | | | | | | 1 | | 2 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni-strokovni / Compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64241 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** |  | | | **30** | | |  | | | |  | | | **75** | |  | **6** |
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| **Nosilec predmeta / Lecturer:** | | | | | Matjaž Vidmar | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski / slovenian | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski / slovenian | | | | | | | | | | | |
| **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):** | | | | | | | |
| Lastnosti in omejitve kovinskih vodnikov: parica, koaksialni kabel in kovinski valovod, pasovna širina in slabljenje koaksialnega kabla. Odboj in lom elektromagnetnega valovanja na meji dveh snovi - dielektrikov, izvedba planarnega valovoda, skupinska zakasnitev, disperzijska enačba in število rodov v planarnem dielektričnem valovodu. Mnogorodovna in enorodovna svetlobna vlakna, surovine in postopki za izdelavo svetlobnih vlaken, mnogorodovna, barvna in polarizacijska disperzija, nelinearni pojavi v svetlobnih vlaknih. Gradniki optičnega omrežja: delilniki, sklopniki, sita, uklonske mrežice, valovnodolžinske kretnice, svetlobni izolatorji in cirkulatorji. Lastnosti svetlobnih izvorov, vzdolžna in prečna koherenca, modulacija izvorov, vrste izvorov: žarnice, tlivke, svetleče diode, laserji v plinih in trdnih snoveh, izvedbe polprevodniških laserjev in njihove lastnosti. Svetlobni modulatorji, fazni elektro-optični modulator, amplitudni elektro-optični modulator, elektro-absorpcijski modulator. Svetlobni sprejemniki: toplotni, fotoupori in fotodiode, kvantni izkoristek, fotouporovni in fotovoltaični režim, zrnati in toplotni šum svetlobnega sprejemnika, izvedbe sprejemnikov, regeneracija takta v optični zvezi, drhtenje takta. Svetlobni ojačevalniki, vlakenski in polprevodniški laserski ojačevalniki, Brillouin-ov in Raman-ov pojav. | | | | | | | |  | | Properties and limitations of metal transmission lines: twisted pair, coaxial cable and metal wave-guide, bandwidth and attenuation of coaxial cable. Reflection and refraction of electromagnetic waves on the boundary of two different dielectrics, implementation of a planar wave-guide, group delay, dispersion equation, and number of modes in a planar dielectric wave-guide. Multi-mode and single-mode optical fibers, raw materials and methods of fabrication, multi-mode, chromatic and polarization-mode dispersion, non-linear effects in optical fibers. Optical-network components: splitters, combiners, filters, diffraction gratings, wavelength multiplexers, light-wave isolators and circulators. Optical-source properties, longitudinal and transversal coherence, source modulation, source types: filament bulbs, gas-discharge bulbs, light-emitting diodes, gas and solid-state lasers and their properties. Light-wave modulators, electro-optical phase modulator, electro-optical amplitude modulator, electro-absorption modulator. Lightwave receivers: thermal, photo-resistors and photo-diodes, quantum efficiency, photo-resistor and photo-voltaic regimes, quantum and thermal noise of an optical receiver, implementations of different receivers, clock recovery, clock jitter. Optical amplifiers, fiber and solid-state amplifiers, Brillouin and Raman effects. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. J. Budin, Optične komunikacije, FE, Ljubljana, 1993. 2. B. Batagelj, M. Vidmar, Optične komunikacije, Laboratorijske vaje, FE, Ljubljana, 2003. 3. J. Budin, Sisitemi optičnih komunikacij, FE, Ljubljana, 1995. 4. <http://antena.fe.uni-lj.si/literatura/> | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Spoznavanje osnovnih zakonitosti vrvične zveze in razlogov za uporabo svetlobnih vlaken. Spoznavanje lastnosti svetlobnih vlaken, gradnikov optičnega omrežja, svetlobnih oddajnikov, svetlobnih modulatorjev, svetlobnih sprejemnikov in svetlobnih ojačevalnikov. | |  | | Learning the fundamentals of guided-wave (wired) communications. Reasons to use optical fibers. Learning optical fibers and other components of optical networks: optical transmitters, optical modulators, optical receivers and optical amplifiers. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Poznavanje (vrvične) zveze z vodenim valovanjem, osnove delovanja in izvedba optičnih vlaken ter pripadajoče terminalne opreme: svetlobni oddajniki, modulatorji, sprejemniki in ojačevalniki. | | |  | Knowledge of guided-wave (wired) communications, principles and implementation of optical fibers and related terminal equipment: optical transmitters, modulators, receivers and amplifiers. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja na katerih se študent seznani s teoretičnimi osnovami, in laboratorijske vaje, kjer nekaj problemov spozna tudi praktično in jih skuša v duhu timskega dela reševati. | | |  | Lectures to explain the theoretical background and laboratory experiments to practically confirm the theory in the spirit of team work. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| pisni izpit, ustno izpraševanje, naloge, projekt  Prispevki k oceni:   * pisne tihe vaje * poročila laboratorijskih vaj * ustno izpraševanje | 50%  50%  po potrebi/  if required | | | | examination, oral, coursework, project  Contibution to the final grade:   * multiple written exams * written laboratory reports * oral examination |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. BOGATAJ, Luka, VIDMAR, Matjaž, BATAGELJ, Boštjan. Opto-electronic oscillator with quality multiplier. IEEE transactions on microwave theory and techniques, ISSN 0018-9480. [Print ed.], Feb. 2016, vol. 64, no. 2, str. 663-668. 2. TRATNIK, Jurij, LEMUT, Primož, VIDMAR, Matjaž. Time-transfer and synchronization equipment for high-performance particle accelerators = Prenos takta in sinhronizacijska oprema za visoko-zmogljive pospeševalnike osnovnih delcev. Informacije MIDEM, ISSN 0352-9045, jun. 2012, letn. 42, št. 2, str. 115-122. 3. STEED, Robert J., PAVLOVIČ, Leon, NAGLIČ, Luka, VIDMAR, Matjaž, et al. Hybrid integrated optical phase-lock loops for photonic terahertz sources. IEEE journal of selected topics in quantum electronics, ISSN 1077-260X. [Print ed.], Jan./Feb. 2011, vol. 17, no. 1, str. 210-217. 4. TRATNIK, Jurij, VIDMAR, Matjaž. 2.8 GHz - 5.7 GHz very fast UWB CCO using discrete-packaged SiGe RF transistors = 2,8 GHz - 5,7 GHz zelo hiter ultra širokopasoven tokovno krmiljen oscilator z diskretnimi SiGe RF tranzistorji. Informacije MIDEM, ISSN 0352-9045, mar. 2011, letn. 41, št. 1, str. 70-72. 5. RASPOR, Adam, VIDMAR, Matjaž. Two double-ring cavity antennas in 19-22 dBi directivity range. Electronics letters, ISSN 0013-5194. [Print ed.], Dec. 2009, vol. 45, no. 25, str. 1288-1289. | | | | | |