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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Antene in razširjanje valov | | | | | | | | | | | | | | |
| **Course title:** | | | Antennas and wave propagation | | | | | | | | | | | | | | |
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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 | | 1 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | Telecommunications | | | | | | | | 1 | | 1 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni-strokovni / Compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64240 | | | | | |
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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):** | | | | | | | |
| Polvalovni dipol, izvedba usmerjene antene, Fraunhofer-jev pogoj za daljne polje, osnove meritev antenskih parametrov. Huygens-ov izvor, antenske odprtine, načrtovanje valovodnih lijakov, kvadratna napaka faze, popravljanje napake faze z zbiralno lečo, leče iz umetnih dielektrikov, antene z upočasnjenim valovanjem. Parabolično zrcalo, izračun gorišča, izbira izreza, osvetlitev zrcala, izkoristek osvetlitve odprtine, antene z več zrcali: Gregorijanska in Cassegrain. Skupine anten in njihovo načrtovanje, napajanje antenskih skupin, električno krmiljenje lastnosti. Polarizacija elektromagnetnega valovanja, definicija polarizacije antene, upoštevanje polarizacijske neusklajenosti v radijski zvezi. Toplotni šum, šumna temperatura antene, naravni izvori šuma na Zemlji in v vesolju. Fresnel-ove cone, razširjanje elektromagnetnega valovanja v prisotnosti naravnih ovir, zrcala in uklanjalniki, odmevna površina predmeta, enačba za domet radarja. Razširjanje elektromagnetnega valovanja v zemeljskem ozračju, absorpcija, lom in odboj v troposferi. Presih jakosti sprejema in popačenje radijskega kanala, statistika presiha, verjetnost izpada radijske zveze, raznoliki sprejem in oddaja. | | | | | | | |  | | Half-wave dipole, implementation of a directional antenna, Fraunhofer far field criteria, basic measurements of antenna parameters. Huygens source, antenna apertures, design of horn antennas, square phase error, phase-error correction with a collimating lens, lenses from artificial dielectrics, slow-wave structures. Parabolic mirror, computation of its focal point, selection of the section, mirror illumination, illumination efficiency, multiple-reflector antennas: Gregorian and Cassegrain. Antenna arrays and their design, array feeding networks, electrical array steering. Polarization of electromagnetic waves, definition of the antenna polarization, accounting for polarization mismatch in a radio link. Thermal noise, antenna noise temperature, natural noise sources on Earth and in the universe. Fresnel zones, propagation of radio waves in the presence of natural obstacles, mirrors and diffractors, radar cross-section, radar range equation. Propagation of electromagnetic waves in the Earth's atmosphere, absorption, refraction and reflection in the troposphere. Signal fading and channel distortion, fading statistics, link-failure probability, transmit and receive diversity. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | |
| 1. J. D. Kraus, Antennas, McGraw-Hill, New York, 1950. 2. J. Budin, Razširjanje radijskih valov, FE, Ljubljana, 1975. 3. M. Vidmar, Sevanje in Razširjanje, Laboratorijske vaje, FE, Ljubljana 1998. 4. <http://antena.fe.uni-lj.si/literatura/> | | | |
| **Cilji in kompetence:** |  | | **Objectives and competences:** |
| Spoznavanje osnovnih zakonitosti anten. Spoznavanje izvedbe usmerjenih anten. Spoznavanje sevanja porazdeljenih izvorov in toplotnega šuma. Spoznavanje razširjanja elektromagnetnega valovanja skozi zemeljsko ozračje ter v prisotnosti ovir. Spoznavanje pojava presiha sprejema in protiukrepov. |  | | Learning fundamental antenna characteristics. Learning directional antenna design. Learning radiation from distributed sources and thermal noise. Learning electromagnetic-wave propagation through the atmosphere and in the presence of obstacles. Learning reception fading and related countermeasures. |
| **Predvideni študijski rezultati:** | |  | **Intended learning outcomes:** |
| Poznavanje zveze v praznem prostoru, pripadajoče terminalne opreme (anten) in pojavov razširjanja valovanja. | |  | Knowledge of free-space communications, related terminal equipment (antennas) and propagation-path effects. |
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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. |

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| **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. | | | |