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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Elektrodinamika | | | | | | | | | | | | | | |
| **Course title:** | | | Electrodynamics | | | | | | | | | | | | | | |
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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 | | | | | Informacijsko komunikacijske tehnologije | | | | | | | | 3. | | zimski | | |
| 1st cycle academic study programme Electrical Engineering | | | | | Information and communications technologies | | | | | | | | 3. | | winter | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni- strokovni/compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64167 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** |  | | | **45** | | |  | | | |  | | | **85** | |  | **7** |
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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):** | | | | | | | |
| Ponovitev osnov elektrotehnike: električna vezja kot nič-dimenzijska naloga. TEM električni vodi kot eno-dimenzijska naloga, telegrafska enačba. Karakteristična impedanca in odbojnost v časovnem prostoru. Odbojnost in valovitost v frekvenčnem prostoru, stojni val. Vod z izgubami v frekvenčnem prostoru. Tri-dimenzijske naloge, ponovitev matematike: koordinatni sistemi, Lame-jevi koeficienti, diferencialne operacije v prostoru. Maxwell-ove enačbe iz integralne oblike v diferencialno, Poynting-ov izrek, valovni enačbi za električno in magnetno polje. Vektorski potencial, Lorentz-ov pogoj, valovni enačbi za skalarni in vektorski potencial, reševanje valovnih enačb za potenciale. Potenciali in točno elektromagnetno polje tokovnega elementa, razvrstitev členov na statično, dinamično in izsevano polje, velikostni razredi členov kot funkcija razdalje in frekvence, sevalna upornost in izkoristek. Ravninski elektromagnetni val v neomejenem prostoru, valovni vektor. Kompleksni valovni vektor, popolni odboj in tuneliranje valovanja. Elektromagnetno polje v omejenem prostoru kot vsota ravninskih valov. Eno-dimenzijski stojni val v kovinskem valovodu, fazna in skupinska hitrost. Več-dimenzijski stojni val v votlinskem rezonatorju. Elektromagnetno valovanje v snovi z izgubami, vdorna globina in kožni pojav. Kvaliteta tuljav in rezonatorjev. Slabljenje TEM vodov. Mikrotrakasti vod. | | | | | | | |  | | Electricity fundamentals refresher: electrical circuits as a zer0-dimensional problem. TEM transmission lines as a one-dimensional problem, telegrapher's equation. Characteristic impedance and reflection coefficient in time domain. Reflection coefficient and standing-wave ratio in frequency domain. Three-dimensional problems, mathematics refresher: coordinate systems, Lame coefficients, differential operations in space. Conversion of Maxwell equations from integral into differential form, Poynting theorem, wave equations for electric and magnetic field. Vector potential, Lorentz choice, wave equations for scalar and vector potential, solutions of potential equations. Potentials and exact electromagnetic field of a current element, static, dynamic and radiation terms, magnitudes of different terms as a function of frequency and distance, radiation resistance and efficiency. Electromagnetic waves in unlimited space, wave vector. Complex wave vector, total reflection and tunnelling. Electromagnetic field in confined space as a sum of free-space waves. One-dimensional standing wave in metal waveguides, phase and group velocity. Multi-dimensional standing wave in cavity resonators. Electromagnetic waves in lossy media, penetration depth and skin effect. Quality of inductors and resonators. Attenuation of TEM transmission lines. Microstrip line. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Učbenik / textbook:  http://antena.fe.uni-lj.si/literatura/ed.pdf  2. Priprava (zapiski) predavanj / lecture notes:  http://antena.fe.uni-lj.si/literatura/ed.zap.pdf  3. Zbirka nalog tihih vaj / collection of exam problems:  http://antena.fe.uni-lj.si/literatura/ed.tv.pdf  4. Rešitve nalog tihih vaj / collection of exam solutions:  http://antena.fe.uni-lj.si/literatura/ed.res.pdf  5. Navodila za laboratorijske vaje / instructions for laboratory experiments:  http://antena.fe.uni-lj.si/studij/eld/navodila\_eld.php | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Spoznavanje osnovnih zakonitosti dinamičnega električnega polja. Spoznavanje pojavov na električnih vodih. Spoznavanje pojava sevanja, ki je osnova brezvrvične (radijske) zveze. Spoznavanje različnih dinamičnih elektromagnetnih pojavov v neomejenem prostoru, v omejenem prostoru, v brezizgubni snovi in v snovi z izgubami. | |  | | Learning fundamental properties of dynamic electromagnetic fields. Learning phenomena on transmission lines. Learning radiation as the basis of wireless communications. Learning different electromagnetic effects in infinite and confined space, in lossless and lossy media. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Poznavanje in razumevanje osnov dinamičnega elektromagnetnega polja, električnih vodov, mehanizma sevanja elektromagnetnih valov, valovanja v neomejenem in omejenem prostoru, valovanja v snovi z izgubami. | | |  | Knowledge and understanding the basics of dynamic electromagnetic fields, transmission lines, radiation mechanisms, waves in infinite and confined space, waves in lossy media. | |
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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 snov predavanj preveri s praktičnimi poskusi in naloge skuša reševati v duhu timskega dela. | | |  | Lectures for theoretical background and laboratory experiments to practically confirm the theory working in a team environment. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Sprotno preverjanje teoretičnega znanja s pisnimi tihimi vajami med predavanji (50% ocene). Sprotno preverjanje praktičnega znanja preko poročil laboratorijskih vaj (50% ocene). Kandidat, ki z oceno tihih vaj preseže 50% in je uspešno opravil vse predpisane laboratorijske vaje, je oproščen ustnega dela izpita. Na željo kandidata lahko z ustnim izpitom v vsakem primeru poskuša popraviti oceno.  Ocenjevalna lestvica:  nezadostno (od 1 do 5), zadostno (6), dobro (7), prav dobro (8), prav dobro (9), odlično (10). | **50%**  **50%**  **po potrebi/**  **if required** | | | | Several written midterm exams during lectures (50% of the final grade). Reports from laboratory experiments (50% of the final grade). Candidates that obtained an average grade higher than 50% on the midterm written exams and performed all laboratory experiments successfully are exempt of the oral examination. Oral examination is also available for candidates that want to improve their grade.  Grade scale:  insufficient (from 1 to 5), sufficient (6), good (7), very good (8), very good (9), excellent (10). |
| **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. | | | | | |