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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Teorija informacij in izvorno kodiranje | | | | | | | | | | | | | | |
| **Course title:** | | | Information Theory and Source Coding | | | | | | | | | | | | | | |
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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 | | | | | **Telekomunikacije** | | | | | | | | 3. | | zimski | | |
| 1st cycle academic study programme Electrical Engineering | | | | | **Telecommunications** | | | | | | | | **3.** | | **winter** | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni- strokovni/compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64168 | | | | | |
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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:** | | | | | Andrej Levstek | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski | | | | | | | | | | | |
| **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):** | | | | | | | |
| Verjetnost, naključne spremenljivke (eksperimenti, dogodki, definicije verjetnosti, diskretna in zvezna naključna spremenljivka, porazdelitvene funkcije, momenti naključnih spremenljivk). Naključni procesi (vzorčna funkcija, statistična in časovna povprečja, avtokorelacija, stacionarnost, ergodičnost, gostota močnostnega spektra). Informacija (definicija informacije, informacijski izvori, entropija, redundanca). Kodiranje in stiskanje podatkov (teorem o izvornem kodiranju, izgubno in brezizgubno stiskanje, entropijsko kodiranje, Lempel-Zivovo kodiranje). Vzajemna entropija in kapaciteta kanala(vzajemna informacija, informacijski kanal, vzajemna entropija diskretnih virov, kapaciteta kanala, diferencialna entropija, kapaciteta Gaussovega kanala). Kodiranje analognih signalov - formatiranje signala (vzorčenje, idealno in regularno vzorčenje, teorem o vzorčenju in rekonstrukciji, vzorčenje ozkopasovnih signalov; kvantizacija, zrnato in prekoračitveno popačenje, dinamično območje). Zvokovni signali (zvok in sluh, značilnosti avdio signala, psihoakustične značilnost sluha, frekvenčno maskiranje, redundanca in irelevanca avdio signala; značilnosti govornega signala, model govornega trakta, redundanca in irelevanca govora). Kodiranje govora (logaritemsko stiskanje z neenakomerno kvantizacijo, A-zakon, prediktivno kodiranje; skalarna kvantizacija (DPCM, ADPCM), vektorska kvantizacija(CELP) . Kodiranje avdio signala (standardizirano kodiranje brez stiskanja: CD, DVD-avdio, DSD; stiskanje signala z izločanjem irelevance, MP2, MP3, AAC). | | | | | | | |  | | Probability, random variables (trials, events, definition of probability, probability density function, mean values, central limit theorem). Stochastic processes (sample function, time averages, ergodicity, power density spectrum). Information (metrics, information sources, entropy, redundancy). Coding and data compaction (source coding theorem, entropy coding, Lempel-Ziv coding). Mutual information and channel capacity (mutual information, information channel, joint entropy of discrete sources, differential entropy, information capacity theorem).  Analogue signal coding – basic formatting (ideal and flat toped sampling, reconstruction of continuous time signals, band-pass signal sampling; quantization, granular and overload noise, dynamic range). Audio signals (sound and hearing, properties of audio signal, perceptual properties of human hearing, frequency masking, redundancy and irrelevance, properties of speech, vocal tract modeling, speech redundancy).  Speech coding (non-linear quantization, A- law compression, predictive coding; scalar quantization (DPCM, ADPCM), vector quantization (CELP). Audio signal coding (standard coding formats: CD, DVD-audio, DSD; lossy compression, MP2, MP3, AAC) | | | | | | | |

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| **Temeljna literatura in viri / Readings:** | | | | | |
| 1. S. Tomažič, Osnove telekomunikacij I, Založba FE in FRI, 2002  2. N. Pavešič, Informacija in kodi, Založba FE in FRI, 2010  3. J.R. Deller, J.G. Proakis, J.H. Hansen, Discrete-time processing of speech signals, MacMillan, New York, 1993  4. N. Moreau, Tools for signal compression, ISTE Ltd. and John Wiley & Sons, Inc., 2009 | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Spoznavanje osnovnih principov informiranja in pojmov, vezanih na prenos informacije. Osnove stiskanja podatkov in njihove teoretične meje. Spoznavanje lastnosti analognih informacijskih signalov, ki so pomembni za postopke kodiranja. Razlikovanje med redundanco in irelevanco ter z njima povezanimi postopki stiskanja podatkov. Spoznavanje različnih načinov kodiranja govornih signalov. Specifičnosti kodiranja avdio signalov in standardni postopki stiskanja. | |  | | Basic principles of information transmission and related backgrounds. Entropy as the basic measure of information. Source coding and basic data compaction algorithms. Fundamental limits of reliable communication over noisy channel. Properties of analogue signals that are important for coding schemes.  Distinction between redundancy and irrelevance. Redundancy removal in advanced speech coding. Basic principles of perceptual coding of audio signals. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Poznavanje in razumevanje osnovnih pojmov teorije informacij, kodiranja izvorov informacije in stiskanja podatkov. Poznavanje lastnosti analognih informacijskih signalov in postopkov njihovega kodiranja, predvsem s stališča degradacij, ki jih vnašajo v dekodirani in rekonstruirani signal. | | |  | Knowledge and understanding of information theory basics, source coding and data compression. Insight in properties of most common analogue signals and appropriate coding schemes. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, laboratorijske vaje, domače naloge | | |  | Lectures, tutorial, homeworks | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: laboratorijske vaje, domače naloge, projekt, 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:  domače naloge  laboratorijske vaje  pisni izpit  ustni izpit | 10%  10%  40%  40% | | | | Type: laboratory exercises, homework, project, 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:  coursework  laboratory exercises  written exam  oral examination |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. LEVSTEK, Andrej, MEDIČ, Igor, PERŠIČ, Boštjan. Frequency domain analysis of the influence of circuit parameters on oscillation frequency. *AEÜ*, ISSN 1434-8411. [Print ed.], 2003, vol. 57, no. 6, str. 423-425.  2. LEVSTEK, Andrej, FURLAN, Jože. Microscopic electric field in the surroundings of ionized impurities in semiconductor. *Journal of electrostatics*, ISSN 0304-3886. [Print ed.], 2003, vol. 57, str. 59-68.  3. FURLAN, Jože, GORUP, Žarko, LEVSTEK, Andrej, AMON, Slavko. Thermally assisted tunneling and the Poole-Frenkel effect in homogenous a-Si. *Journal of applied physics*, ISSN 0021-8979, 2003, vol. 94, no. 12, str. 7604-7610.  4. LEVSTEK, Andrej, PIRC, Matija. Načrtovanje umetne linije za standardni sukani par. *Elektrotehniški vestnik*, ISSN 0013-5852. [Slovenska tiskana izd.], 2008, letn. 75, št. 3, str. 91-96.  5. LEVSTEK, Andrej. Amplitude stabilization in quadrature oscillator for low harmonic distortion = Stabilizacija amplitude v kvadraturnem oscilatorju za nizko harmonično popačenje. *Informacije MIDEM*, ISSN 0352-9045, 2013, letn. 43, št. 3, str. 185-192 | | | | | |