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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Operacijske raziskave v telekomunikacijah | | | | | | | | | | | | | | |
| **Course title:** | | | Operations research in telecommunications | | | | | | | | | | | | | | |
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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:** | | | | | | | | | | | | 64243 | | | | | |
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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 Košir | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | Slovensko / Slovenian | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | Slovensko / 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):** | | | | | | | |
| Algoritem in numerična analiza (algoritem, časovna in prostorska zahtevnost).  Teorija grafov (opis, operacije na grafih, osnovni grafovski algoritmi, izbrane lastnosti grafov).  Uvod v operacijske raziskave in optimizacijo. Optimizacijska naloga (formulacija, tipi rešitev, kriterijske funkcije). Linearno programiranje in celoštevilsko programiranje (predstavitev, simpleksna metoda, primeri iz TK). Analiza mreže (maksimalen pretok, minimalna cena, najkrajša pot). Nelinearna optimizacija (gradientna in Newtonova metoda, optimizacija pri pogoju). Markovski verige (klasifikacija stanj, ergodičnost, uporaba). Teorija časovnih vrst in teorija čakalnih vrst (osnovna analiza). Teorija odločitev (predstavitev, uporaba). Pomembne aplikacije v TK.  Optimalnost s stališča uporabnikove interakcije in optimizacija z uporabnikom v središču. | | | | | | | |  | | Algorithm and numerical analysis (algorithm, time and space complexity).  Graph theory (description, operations on graphs, basic graph algorithms, the properties of graphs).  Introduction to operational research and optimization. Optimization task (formulation of solutions, cost function). Linear programming and integer programming (simplex method, examples from TC). Network analysis (maximum flow, minimum price, shortest path). Nonlinear optimization (gradient and Newton methods, optimization). Markov chains (classification of states, ergodicity). Time series and traffic models, queuing theory (primary analysis). Important applications in telecommunications. Optimal user interaction and the user-centric optimization. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | |
| 1. W. L. Winston: Operations research Applications and Algorithms, Brooks/Cole, 2004. 2. Mauricio G.C. Resende, Panos Pardalos: Handbook of Optimization in Telecommunications, Springer, 2006. 3. M. W. Carter, C. C. Price: Operations Research, A Practical Introduction, CRC Press, 2000. 4. M. X. Cheng, Y. Li, D.-Z. Du: Combinatorial Optimization in Communication Networks, Springer, 2006. 5. A. Košir: Operacijske raziskave v telekomunikacijah, Založbe FE in FRI, 2013. | | | |
| **Cilji in kompetence:** |  | | **Objectives and competences:** |
| Spoznavanje osnov optimizacijskih metod in algoritmov. Spoznavanje osnovnih principov optimizacije in njenih postopkov z aplikacijo v telekomunikacijah. Spoznavanje različnih možnosti optimizacije in racionalizacije procesov ter postopkov v telekomunikacijah.  Spoznati razrede optimizacijskih problemov in njihovih osnovnih rešitev. |  | | Basics optimization methods and algorithms. Understanding the basic principles of optimization and its procedures with application in telecommunications. Getting to know the various options to optimize and streamline processes and procedures in telecommunications. Getting to know selected classes of optimization problems and their basic solutions. |
| **Predvideni študijski rezultati:** | |  | **Intended learning outcomes:** |
| * Razviti in zgraditi optimizacijski problem s kriterijsko funkcijo na podlagi opisa realne situacije. * Poznati in uporabiti programska in matematična orodij za reševanje optimizacijskih problemov. * Izbrati ustrezne metode in orodja glede na predstavljene lastnosti problema. * Razumeti uporabo modelov prometa in modelov čakalnih vrst * Poznati pomen uporabe operacijskih raziskav na področju telekomunikacij * Poznati in razumeti pomembne rešitve optimizacijskih problemov v telekomunikacijah | |  | * To development and design an optimization problem and its criteria function based on a description of a real situation. * To know and use of programming and mathematical tools for solving optimization problems. * The ability to select the most appropriate method and tool based on the problem description. * To understand telecommunication traffic models and queueing models * To understand the role of operational research in the field of telecommunications. * To know and understand relevant optimization solutions in telecommunications |
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| **Metode poučevanja in učenja:** | |  | **Learning and teaching methods:** |
| Predavanja, laboratorijske vaje (uporaba obravnavanih metod in postopkov) ter projekti. | |  | Lectures, laboratory exercises (using the presented methods and procedures), and projects. |

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| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | **Assessment:** |
| Način: Vadnice, ustni izpit, pisni izpit  Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne.  Sprejeta poročila so pogoj za pristop k izpitu.  Prispevki k oceni:   * Poročila lab. vaj * Pisni izpit * Ustni izpit | 30 %  30 %  40 % | Type: homeworks, oral exam, written exam  Negative grades: from 1 to 5, positive grades: from 6 to 10.  Positive evaluation of lab reports is a prerequisite for the exam.  Contributions to final grade:   * Lab reports * Written exam * Oral exam |
| **Reference nosilca / Lecturer's references:** | | |
| 1. VODLAN, Tomaž, TKALČIČ, Marko, KOŠIR, Andrej. The impact of hesitation, a social signal, on a user's quality of experience in multimedia content retrieval. Multimedia tools and applications, 2015, vol. 74, no. 17, str. 6871-6896. 2. DROFTINA, Uroš, ŠTULAR, Mitja, KOŠIR, Andrej. A diffusion model for churn prediction based on sociometric theory. Advances in data analysis and classification, 2015, vol. 9, iss. 3, str. 341-365. 3. PESKO, Marko, JAVORNIK, Tomaž, VIDMAR, Luka, KOŠIR, Andrej, ŠTULAR, Mitja, MOHORČIČ, Mihael. The indirect self-tuning method for constructing radio environment map using omnidirectional or directional transmitter antenna. EURASIP Journal on wireless communications and networking, 2015, vol. 2015. 4. ODIĆ, Ante, TKALČIČ, Marko, TASIČ, Jurij F., KOŠIR, Andrej. Predicting and detecting the relevant contextual information in a movie-recommender system. Interacting with computers, 2013, vol. 25, no. 1, str. 74-90. 5. TKALČIČ, Marko, ODIĆ, Ante, KOŠIR, Andrej. The impact of weak ground truth and facial expressiveness on affect detection accuracy from time-continuous videos of facial expressions. Information sciences, 2013, vol. 249, str. 13-23. | | |