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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Načrtovanje, razvoj in upravljanje telekomunikacijskih sistemov | | | | | | | | | | | | | | |
| **Course title:** | | | Telecommunication system design and management | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| doktorski študijski program tretje stopnje Elektrotehnika | | | | | Ni smeri | | | | | | | | 1 | |  | | |
| 3rd cycle: doctoral study programme Electrical Engineering | | | | |  | | | | | | | |  | |  | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Izbirni/elective | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64871 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **30** | **30** | | |  | | |  | | | |  | | | **65** | |  | **5** |
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| **Nosilec predmeta / Lecturer:** | | | | | doc. ddr. Iztok Humar | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | **slovensko (angleško) / slovene (english)** | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | |  | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Priporočeno predznanje iz:   * matematike, verjetnosti, statistike * telekomunikacijskih sistemov, storitev, protokolov in tehnologij | | | | | | | | |  | Recommended background in:   * mathematics, probability, statistics, * telecommunication systems, services, protocols and technologies | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Poglobljeno znanje s področij načrtovanja,razvoja, modeliranja, planiranja, simulacija, emulacij, vodenja in upravljanja telekomunikacijskih sistemov in storitev. Predstavitev perečih raziskovalnih problemov s posameznih področij.  Analize statističnih porazdelitev prometa in obremenitev. Teorija čakalnih vrst, strežba, stopnja strežbe. Ozko grlo, zamašitve, blokada, razvoj pristopov za preprečevanje in reakcije. Načrtovanje v tokokrogovno komutiranih sistemih, izgubni sistemi. (Erl B, Erl C, Engset). Načrtovanje v paketnih sistemih s čakalnimi vrstami (M/M/1). Splošni model strežne vrste. Vrednotenje učinkovitosti, zmogljivosti.  Zasnova in izgradnja modela. Uporaba simulacij in emulacij za analizo delovanja sistemov.  Mehanizmi in protokoli za zagotavljanje kakovosti storitev. Osnovni principi: statistični multipleks, presežno zagotavljanje kapacitete. Krmiljene entitete. Elastične in neelastične aplikacije. Splošni koncepti: rezervacija virov, nadzor dostopa, ločevanje storitev, krmiljenje v odprtih in sklenjenih zankah. Razvoj in nadgradnja pristopov za zagotavljanje kakovosti storitev. Uporabniške izkušnja. Razvoj načinov in metrik za vrednotenje prejete kakovosti.  Meritve in analiza značilnosti telekomunikacijskega prometa, obremenitev, omrežnih gradnikov in aplikacij. Modeliranje značilnosti, vrednotenje in pomen njihovega vpliva na zmogljivost sistemov. Testirane združljivosti in verifikacija telekomunikacijskih sistemov.  Centralno in porazdeljeno upravljanje in nadzor telekomunikacijskih sistemov. Modeli za upravljanje, protokoli in informacijski modeli, beleženje in zaračunavanje.  Zagotavljanje energijske in stroškovne učinkovitosti telekomunikacijskih sistemov, pristopi za optimizacije porabe. Tehno-ekonomski vidiki načrtovanja. | | | | | | | |  | | Extended knowledge of telecommunication system design, modelling planning, simulation, emulation and management of telecommunication systems and services.  Statistical distributions of network traffic and loads. Queuing system theory, service, service rate. Bottleneck, congestion, blocking, avoiding and reactions. Design in circuit switched networks, loss systems (Erl B, Erl C model). Design in packet switched networks (M/M/1). Generalized model of a queue. Efficiency and performance evaluation.  Building a model of telecommunication system. Simulations and emulations usage for telecommunications system evaluation.  Mechanisms and protocols for Quality of Service (QoS). Basic concepts: statistical multiplexing, overprovisioning. Controlled entities. Elastic and non-elastic applications. General concepts: resource reservation, admission control, service differentiation, open and closed-loop traffic control. Design and upgrade of QoS approaches. User perceived quality, Quality of Experience (QoE). Design and useage of QoE evaluation metrics and procedures. Mean opinion score (MOS).  Telecommunication traffic, load, application and element measurements and characterization. Characteristics modeling, evaluation and understanding their influences on system’s performances. Conformance testing and verification of telecommunication systems.  Management and control of telecommunication systems. Management models, protocols and information models. Accounting and billing.  Energy and cost efficiency of telecommunication systems, optimization approaches. Techno-economic aspect of telecommunication system design. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Humar I, Bešter J: Načrtovanje, razvoj in upravljanje telekomunikacijskih sistemov (v pripravi)  2. Raghavan S, Anandalingam G (2010) Telecommunications Modeling, Policy, and Technology, Springer  3. Promise J-I (2010) Mobile Communications Network Planning: Network Planning Issues and Strategies for Improving Network Resource Utilization, Lambert  5. Pang S (2009) Successful Service Design for Telecommunications: A comprehensive guide to design and implementation, Wiley  5. Iversen V B (2007) Teletraffic Engineering and Network planning, Technical University of Danmark  6. Leon-Garcia A, Widjaja I (2000) Communication Networks, Fundametnatl Concepts and Key Architectures, McGraw-Hill  7. Wang H (2000) Telecommunications Network Management, McGraw Hill  8. Sansò B, Soriano P (1999) Telecommunications Network Planning, Springer  9. Članki, objavljenih v revijah/Papers published in journals:  - IEEE Communications Surveys & Tutorials, http://www.comsoc.org/livepubs/surveys/index.html  - International Journal of Network Management  http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099-1190 | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Pridobiti poglobljena znanja, veščine in pristope za raziskovalno delo, analitično mišljenje in sposobnost kritičnega vrednotenja znanstveno-raziskovalnih, razvojnih in implementacijskih problemov s področja načrtovanja, modeliranja, planiranja, simulacij, emulacij, vodenja, merjenja, testiranja, upravljanja in nadzora telekomunikacijskih sistemov na podlagi podrobnega poznavanja komunikacijskih tehnologij, protokolov in storitev.  Sposobnost samostojne identifikacije in pristopa k znanstveno-raziskovalnim izzivom, reševanja kompleksnejših problemov ter njihovo kritično vrednotenje dobljenih rezultatov in rešitev. | |  | | To acquire extended knowledge, skills and approaches for research work, analytical thinking and critical evaluation of scientific, development and implementation problems from the field of telecommunication system design, modelling, planning, simulation, emulation, measurement, testing, management and control, based on a good knowledge of telecommunication technologies and services.  Autonomous identification and approach to a scientific research issues, solving of complex problems and critical evaluation of the results and solutions. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Poznavanje in razumevanje poglobljenih principov in razvojno-raziskovalnih izzivov s področja načrtovanja, razvoja in upravljanja telekomunikacijskih sistemov.  Pridobljeno znanje predstavlja močno orodje pri raziskovalnem delu z navedenih področij ter ponuja visokokvalificiranim strokovnjakom iz industrije analitične pristope k reševanju zahtevnejših strokovnih problemov, hkrati pa nudi možnost povezovanje oz. pouporabo pri podobnih problematikah v isti ali sorodnih vedah. | | |  | To know and understand extended principles and research and development issues from the field of Telecommunication systems’ design and management.  The acquired knowledge serves for a research and offers senior experts analytical approaches for solving high-tech problems in industry.  It also offers a good chance for a re-usage in similar fields. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, samostojen študij in raziskovalno delo, seminar. | | |  | Lectures, self-study and research work, seminar. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Seminar in ustni zagovor. | **100** | | | | Seminar and oral exam. |
| **Reference nosilca / Lecturer's references:** | | | | | |
| Golja M, Stojmenova E, Humar I (2014) Interactive TV user interfaces : how fast is too fast?. Multimedia tools and applications, 71(1): 61-76  Humar I, Podnar M (2013) Implementation and performance evaluation of IGMP snooping supporting multicast functionality on Linux-based Ethernet switches. *T*elecommunication systems 52(3): 1559-1572  Umberger M, Lumbar S, Humar I (2012) Modeling the influence of network delay on the user experience in distributed home-automation networks. Information systems frontiers 14 (3): 571-584  Humar I, Ge X, Xiang L, Jo M, Chen M. Zhang J (2011) Rethinking energy efficiency models of cellular networks with embodied energy. IEEE network, 25(2): 40-49  Umberger M, Humar I, Kos A, Guna J, Žemva A, Bešter J (2009) The integration of home-automation and IPTV system and services. Computer standards & interfaces, 31(4): 675-684 | | | | | |