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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Načrtovanje in upravljanje komunikacijskih sistemov | | | | | | | | | | | | | | |
| **Course title:** | | | Design and management of communication systems | | | | | | | | | | | | | | |
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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:** | | | | | | | | | | | | 64242S | | | | | |
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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:** | | | | | Janez Bešter, Iztok Humar | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | Slovenščina / Slovenian  Angleški (mentorsko) / English (consultations) | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | Slovenščina / Slovenian  Angleški (mentorsko) / English (consultations) | | | | | | | | | | | |
| **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):** | | | | | | | |
| Uvod v načrtovanje, modeliranje, vodenje in upravljanje komunikacijskih sistemov.  Načrtovanje sistemov in komunikacijski inženiring. Elastične in neelastične aplikacije, teorija prometa in teorija čakalnih vrst. Načrtovanje v tokokrogovno komutiranih sistemih. Načrtovanje v paketnih sistemih. Ozka grla in zamašitve v omrežju.  Analiza učinkovitost in zmogljivosti.  Meritve značilnosti telekomunikacijskega prometa, omrežnih gradnikov in aplikacij, testi skladnosti.  Simulacije in emulacije omrežij in prometa: orodja in pristopi.  Koncepti zagotavljanja kakovosti storitev: statistični multipleks, presežno zagotavljanje kapacitete, rezervacija virov, nadzor dostopa, ločevanje storitev. Mehanizmi in protokoli za zagotavljanje kakovosti storitev v sodobnih omrežjih. Vrednotenje in merjenje prejete kakovosti. Srednja mnenjska vrednost.  Razpoložljivost, zanesljivost, dostopnost sistemov, redundance.  Energetski in tehnoekonomski vidiki načrtovanja omrežij.  Upravljanje in nadzor v telekomunikacijskih omrežjih: modeli za upravljanje telekomunikacijskih omrežij, protokoli in informacijski modeli, zaračunavanje.  Operaterski procesi.  Načrtovanje in upravljanje v pri oblačni infrastrukturi in internetu stvari: virtualizacija, integracija, orkestracija, avtomatizacija.  Standardizacija in regulativa v komunikacijah. | | | | | | | |  | | Introduction to design, planning, modelling, control and management of communication systems.  Communication system design and engineering. Elastic and non-elastic applications. Traffic theory and queuing theory. Design and planning of circuit switched networks. Design and planning of packet switched networks. Network bottleneck and Congestion control.  Efficiency and performance evaluation.  Network traffic characterization and measurements, performance evaluation and conformance testing.  Network and traffic simulation and emulation: tools and approaches.  Quality of Service concepts: statistical multiplexing, overprovisioning, resource reservation, admission control, service differentiation. QoS mechanisms and protocols in contemporary networks. User perceived quality. Quality of Experience evaluation and measurements. Mean opinion score.  Availability and accessibility of system, redundancy.  Energy efficient and techno-economic aspects of network planning.  Management and control of telecommunication networks and systems. Management models, protocols and information models. Accounting and Billing.  Design and management for Cloud infrastructure and Internet of Things: virtualization, integration, orchestration, automation.  Standardization and regulation in communications. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Haesik Kim: Wireless Communicatons Systems Desing, Wiley, 2015 2. Laszlo Lakatos, Laszlo Szeidl, Miklos Telek: Introduction to Queueing Systems with Telecommunication Applications, Springer, 2013th Edition 3. Villy B. Iversen: Teletraffic Engineering and Network Planning, Technical University of Denmark, 2007. 4. Članki, objavljenih v revijah, npr: IEEE Communications Surveys & Tutorials, <http://www.comsoc.org/livepubs/surveys/index.html> IEEE Communications Surveys & Tutorials, <http://www.comsoc.org/livepubs/surveys/index.html> | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Cilj predmeta je pridobiti znanja in veščine za potrebe načrtovanja, modeliranja, planiranja, simulacij, emulacij, vodenja, merjenja, testiranja, upravljanja in vodenja telekomunikacijskih sistemov na podlagi poznavanja komunikacijskih tehnologij in storitev za potrebe razvoja, nadgradnje ali vzdrževanja sistemov v operaterskih okoljih.  Študenti bodo pridobili potrebna znanja in veščine na področju razumevanja parametrov zmogljivosti telekomunikacijskih sistemov in njihovega kritičnega vrednotenja. | |  | | The objective is to acquire fundamental knowledge and skills for telecommunication system design, modelling, planning, simulation, emulation, measurement, testing, management and control, based on a good knowledge of telecommunication technologies and services for development, upgrade, and support of telecommunication systems in operator's environment.  Students will acquire fundamental knowledge and skills in understanding performance parameters of telecommunication systems and their critical estimation and evaluation. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Poznavanje in razumevanje temeljnih principov telekomunikacijskega inženiringa.  Pridobljeno znanje predstavlja dobre temelje za delo/neposreden prenos v operaterska okolja in industrijo, hkrati pa nudi možnost nadgradnje in povezovanje oz. souporabo pri podobnih problematikah v isti ali sorodnih vedah. | | |  | To know and understand basic principles of Telecommunications engineering.  The acquired knowledge serves as a good background for a direct application and work in industry or with network operators, as well as a good chance for a further upgrade or re-usage in similar fields. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, na katerih se študent seznani s teoretičnimi osnovami, ter laboratorijske vaje, kjer probleme spozna tudi praktično in jih v timu rešuje skozi projektno delo. Eizobraževanje. Ogledi in vabljeni predavatelji. | | |  | Lectures for theoretical aspects,  laboratory exercises and team work for real-case scenarios and problem solving through project work. Elearning. Study visits and invited lecturers. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: pisni izpit, ustni izpit.  Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne.  Uspešna izvedba 80% laboratorijskih vaj je predpogoj za prijavo na pisni izpit.  Prispevki k oceni:   * pisni izpit * ustni izpit | 50%  50% | | | | Type: written exam, oral exam.  Negative grades: from 1 to 5, positive grades: from 6 to 10.  Successful completion of at least 80% of the laboratory exercises is prerequisite for the written exam.  Contributions to the final grade:   * written exam * oral examination |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. STERLE, Janez, VOLK, Mojca, SEDLAR, Urban, BEŠTER, Janez, KOS, Andrej. Application-based NGN QoE controller. *IEEE communications magazine*, ISSN 0163-6804. [Print ed.], Jan. 2011, vol. 49, no. 1, str. 92-101. 2. SAVIĆ, Dragan, BEŠTER, Janez, PUSTIŠEK, Matevž, TOMAŽIČ, Sašo, POTORTI, Francesco, FURFARI, Francesco. CostGlue : simulation data exchange in telecommunications. *Simulation*, ISSN 0037-5497. [Print ed.], Apr. 2008, vol. 84, no. 4, str. 157-168. 3. HUMAR, Iztok, GE, Xiaohu, XIANG, Lin, JO, Minho, CHEN, Min, ZHANG, Jing. Rethinking energy efficiency models of cellular networks with embodied energy. *IEEE network*, ISSN 0890-8044, 2011, vol. 25, no. 2, str. 40-49. 4. KOS, Andrej, BEŠTER, Janez. Razvoj in uvajanje novih telekomunikacijskih storitev. Elektrotehniški vestnik, ISSN 0013-5852. [Slovenska tiskana izd.], 2002, letn. 69, št. 3-4, str. 221-226. 5. KOS, Andrej, VOLK, Mojca, BEŠTER, Janez. Quality assurance in the IMS-based NGN environment. V: CRANLEY, Nicola (ur.), MURPHY, Liam (ur.). Handbook of research on wireless multimedia : quality of service and solutions. Hershey; New York: Information Science Reference, cop. 2009, str. 240-257. | | | | | |