

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Načrtovanje brezžičnih omrežij
Course title:	Wireless Network Design

Študijski program in stopnja Study programme and level	Modul Module	Letnik Academic year	Semester Semester
Informacijske in komunikacijske tehnologije, 2. stopnja	Komunikacijske tehnologije	1	2
Information and Communication Technologies, 2 nd cycle	Communication Technologies	1	2

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: IKT2-640

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Druge oblike	Samost. delo Individ. work	ECTS
15	15			15	105	5

**Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transferred to individual work.*

Nosilec predmeta / Lecturer: Prof. dr. Mihael Mohorčič

Jeziki / Languages: **Predavanja / Lectures:** slovenščina, angleščina / Slovenian, English
Vaje / Tutorial:

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Zaključen študijski program prve stopnje s področja naravoslovja, tehnike ali računalništva.

Prerequisites:

Student must complete first-cycle study programmes in natural sciences, technical disciplines or computer science.

Vsebina:

Uvod:
osnovni pojmi in terminologija pri načrtovanju omrežij, pomen načrtovanja brezžičnih omrežij in njihove optimizacije, proces načrtovanja in optimizacije brezžičnih omrežij, referenčne arhitekture brezžičnih omrežij s stališča načrtovanja
Postopki načrtovanja brezžičnih omrežij:
analiza slabljenja signala, analiza interference, bilanca povezave, načrtovanje pokritja, načrtovanje kapacitete, načrtovanje frekvenčne porazdelitve
Načrtovanje posameznih brezžičnih povezav (PTP):
povezave brez ovir na črti vidnosti (LOS),

Content (Syllabus outline):

Introduction:
concepts and terminology of network design, the importance of wireless network design and optimization, the process of design and optimization of wireless networks, reference wireless network architectures from the network design perspective
Wireless Network Design:
propagation path loss, interference analysis, link budget calculation, coverage planning, capacity planning, frequency planning
Single Wireless Link Design (PTP):
line-of-sight (LOS) PTP links,
non-LOS PTP links

povezave z ovirami na črti vidnosti (NLOS)
Načrtovanje dostopovnih sistemov (PMP):
omrežje brez ovir na črti vidnosti (LOS), omrežje
z ovirami na črti vidnosti (NLOS)
Načrtovanje celičnih omrežij:
celična omrežja z omejitvijo pasovne širine,
celična omrežja z omejitvijo nivoja interference
Izzivi načrtovanja omrežij četrte generacije

Wireless Access Network Design (PMP):
LOS wireless access networks,
NLOS wireless access networks
Cellular Network Design:
bandwidth limited cellular systems, interference
limited cellular systems
Challenges of Designing 4G Wireless Networks

Temeljna literatura in viri / Readings:

Izbrana poglavja iz naslednjih knjig: / Selected chapters from the following books:

- A. R. Mishra, *Advanced Cellular Network Planning and Optimisation*, Wiley, 2007. ISBN 978-0-470-05763-6
- J. Kennington, E. Olinick, D. Rajan, Eds. *Wireless Network Design: Optimization Models and Solution Procedures*, Springer, 2010. ISBN 978-1-4419-6110-5
- M. P. Clark, *Wireless Access Networks: Fixed Wireless Access and WLL Networks -- Design and Operation*, Wiley, 2010. ISBN 978-0470497401
- L. Korowajczuk Edt. *LTE, WiMAX and WLAN Network Design, Optimization and Performance Analysis*, Wiley, 2011, ISBN 978-0-470-74149-8
- G. Miao, G. Song, *Energy and Spectrum Efficient Wireless Network Design*, Cambridge University Press, 2014, ISBN 978-1-107-03988-9

Cilji in kompetence:

Cilj predmeta je seznaniti študenta z znanji s področja telekomunikacijskih sistemov.

Kompetence študenta bodo po uspešno opravljenem predmetu obsegale sposobnost analize, sinteze in predvidevanja rešitev ter posledic ter obvladanje raziskovalnih metod, postopkov in procesov in razvoj kritične ter samokritične presoje.

Objectives and competences:

The aim of the course is to familiarize the student with the knowledge in the field of telecommunication systems.

The competencies of the students completing this course successfully will include the ability to analyse, synthesize and anticipate solutions and consequences, to gain the mastery over research methods, procedures and processes and a development of the critical judgment.

Predvideni študijski rezultati:

Študenti bodo z uspešno opravljenimi obveznostmi tega predmeta pridobili:

- poznavanje procesa načrtovanja in optimizacije brezžičnih omrežij in njegovega pomena
- poznavanje osnovnih postopkov pri načrtovanju brezžičnih omrežij
- poznavanje razlike med načrtovanjem posameznih brezžičnih povezav, dostopovnih sistemov in celičnih omrežij
- poznavanje zveze med bilanco radijske povezave in dimenzioniranjem brezžičnega omrežja
- poznavanje in razumevanje celotnega procesa načrtovanja brezžičnih omrežij

Intended learning outcomes:

Students successfully completing this course will acquire:

- knowledge of objectives and general outline of wireless network design and optimisation
- knowledge of basic steps of wireless network design
- knowledge of the difference in designing single-link system, access system and cellular system
- understanding of the relation between the radio link budget and network dimensioning
- understanding of the overall wireless network design process
- understanding of the impact of different

- razumevanje različnih vplivov na izračun bilance radijske povezave
- sposobnost izračuna bilance radijske povezave in njene uporabe pri načrtovanju brezžičnega omrežja
- sposobnost načrtovanja enostavnega brezžičnega omrežja

- factors on the radio link budget
- the ability to calculate radio link budget and apply it in the wireless network design process
 - the ability to design simple wireless network

Metode poučevanja in učenja:

Predavanja, seminar, konzultacije, individualno delo

Learning and teaching methods:

Lectures, seminar, consultancy, individual work

Načini ocenjevanja:

Delež (v %) /

Weight (in %)

Assessment:

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Seminarska naloga	50 %	Seminar work
Ustni zagovor seminarske naloge	50 %	Oral defense of seminar work

Reference nosilca / Lecturer's references:

- C. Fortuna, A. Bekan, T. Javornik, G. Cerar, **M. Mohorcic**, "Software interfaces for control, optimization and update of 5G machine type communication networks", *Computer networks : the international journal of computer and telecommunications networking*, ISSN 1389-1286. [Print ed.], 2017, vol. 129, part 2, pp. 373-383, doi: [10.1016/j.comnet.2017.06.015](https://doi.org/10.1016/j.comnet.2017.06.015).
- M. Sociu, T. Solc, L. Cremene, **M. Mohorcic**, C. Fortuna, "Discrete transmit power devices in dense wireless networks : methodology and case study", *IEEE access*, ISSN 2169-3536, 2017, vol. 5, pp. 1762-1778, doi: [10.1109/ACCESS.2017.2669403](https://doi.org/10.1109/ACCESS.2017.2669403).
- C. Fortuna, **M. Mohorčič**, "A framework for dynamic composition of communication services", *ACM transactions on sensor networks*, vol. 11, no. 2, pp. 31-1-31.10, 2014.
- T. Šolc, C. Fortuna, **M. Mohorčič**, "Low-cost testbed development and its applications in cognitive radio prototyping". V: M.-G. di Benedetto, ed. *Cognitive radio and networking for heterogeneous wireless networks: recent advances in visions for the future*, Springer, 2015, pp. 361-405. ISBN 978-3-319-01718-1
- M. Pesko, T. Javornik, L. Vidmar, A. Košir, M. Štular, **M. Mohorčič**, "The indirect self-tuning method for constructing radio environment map using omnidirectional or directional transmitter antenna", *EURASIP Journal on wireless communications and networking*, 2015, 12 pp., doi: 10.1186/s13638-015-0297-2.