

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet: Razširjanje radijskih valov in antene
Course title: Radio Waves Propagation and Antennas

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: IKT2-643

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. Tomaž Javornik

Jeziki / Predavanja / Lectures: slovenščina, angleščina / Slovenian, English
Languages: 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:
 elektromagnetni spekter
 radijski sistemi
 dostopovne sheme
 Lastnosti elektromagnetnih valov:
 Maxwellove enačbe
 ravninski radijski valovi
 polarizacija
 Mehanizmi razširjanja:
 odboj, lom in prenos
 sipanje na hrapavi površini
 geometrijska optika
 uklon

Content (Syllabus outline):

Introduction:
 electromagnetic spectrum,
 radio systems
 multiple accessed schemes
 Properties of electromagnetic waves:
 Maxwell equations,
 plane waves,
 polarization
 Propagation mechanisms:
 reflection, refraction and transmission
 rough surface scattering
 geometrical optics
 diffraction

<p>Presih in senčenje: senčenje ozkopasovni hitri presih širkopasovni hitri presih</p> <p>Osnove anten: principi antenski parametri antenska polja rog, zanka, spiralne in »patch« antene</p> <p>Modeli razširjanja: osnovni modeli: prazen prostor, ravna zemeljska površina, bilanca povezave modeli za celične komunikacijske sisteme: Okumura Hata, COST231, 3GPP modeli model za povezave točka področje: ITU-R P.1812, ITU-R P.1546</p> <p>Satelitski kanal: učinki troposfere: slabljenje, odboji, nebesni šum ionosferski učinek: Faradejeva rotacija, skupinska zakasnitev, disperzija, ionosfersko utripanje</p> <p>Napredne teme: več-antenski sistemi, sistemi MIMO, pametne antene, masivni MIMO</p>
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<p>Fading and shadowing shadowing narrowband fast fading wideband fast fading</p> <p>Antenna fundamentals: principles, antenna parameters antenna arrays horn, loop, helical and patch antennas</p> <p>Propagation models: basic models: free space loss, plane earth loss, link budget models for cellular communication systems: Okumura Hata, COST231, 3GPP models point to area channel models: ITU-R P.1812, ITU-R P.1546</p> <p>Satellite channel: tropospheric effects: attenuation, reflection, sky noise ionospheric effects: Faraday rotation, group delay, dispersion, ionospheric scintillation</p> <p>Advanced topics: multi antenna systems: MIMO systems, smart antennas, massive MIMO</p>
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Temeljna literatura in viri / Readings:

<p>Izbrana poglavja iz naslednjih knjig: / Selected chapters from the following books:</p> <ul style="list-style-type: none"> • S. Saunders A. Zavala <i>Antennas and Propagation for Wireless Communication Systems</i>, 2nd Edition, A John Wiley and Sons Ltd, 2007. ISBN 978-0-470-84879-0 • A. F. Molisch, <i>Wireless Communications</i>, John Wiley & Sons, Chichester, West Sussex, 2010, ISBN 978-0-470-74186-3 • S. Haykin, <i>Communication Systems</i>, International Student Version, Wiley, 2009. ISBN 978-0-470-16996-4 • A. Paulraj, R. Nabar, D. Gore, <i>Introduction to space-time wireless communications</i>, Cambridge University Press, 2003. ISBN 0-521-82615-2 • C. A. Balanis, P. I. Ioannides, <i>Introduction to Smart Antennas</i>, Morgan & Claypool Publishers, Jan 1, 2007 - Technology & Engineering. ISBN 1598291769

Cilji in kompetence:

<p>Predmet je uvod v problematiko razširjanja radijskih valov in antenskih sistemov ter ima namen posredovati študentom sistemsko znanje o osnovnih principih razširjanja radijskih valov v prizmenih in satelitskih komunikacijah. Poleg osnovnih modelov razširjanja radijskega valovanja v praznem prostoru so povzeti tudi najpomembnejši modeli v celičnih, satelitskih in radiodifuzijskih komunikacijskih sistemih. Na koncu</p>

Objectives and competences:

<p>This course is an introduction to the problematic of radio wave propagation and antenna system and it is intended to provide students with understanding of radio wave propagation principles in terrestrial and satellite communications. Besides basic channel models of radio wave propagation, the most important channel models in cellular, satellite and broadcast telecommunication systems are given. At the end, an overview of advanced antenna</p>

predmet podaja pregled naprednih antenskih tehnik v sedanjih in bodočih radijskih komunikacijskih sistemih.

Kompetence študenta bodo po uspešno opravljenem predmetu obsegale uporabno strokovno znanje o razširjanju radijskih valov in antenah.

technique in existing and emerging radio communication systems is presented.

The competencies of the students completing this course successfully will include applicable expert knowledge of radio waves propagation and antennas.

Predvideni študijski rezultati:

Študenti bodo z uspešno opravljenimi obveznostmi tega predmeta pridobili:

- poznavanje osnovnih principov razširjanja valovanja v prizemnih in satelitskih komunikacijskih sistemih
- poznavanje omejitev radijskega kanala in njihov vpliv na načrtovanje komunikacijskih sistemov
- poznavanje stanja pri modeliranju radijskih komunikacijskih sistemov v prizemnih in satelitskih komunikacijskih sistemih
- znanje o načrtovanju bilance povezave radijskih sistemov

Intended learning outcomes:

Students successfully completing this course will acquire:

- knowledge of basic principles of radio propagation in terrestrial and satellite communication system
- knowledge of the limitations of radio channels and their impact on communication system design
- the state of the art of the radio channel modeling in terrestrial and satellite communication system
- knowledge of the design link budget of radio communication systems

Metode poučevanja in učenja:

Predavanja, seminar, konzultacije, individualno delo

Learning and teaching methods:

Lectures, seminar, consultancy, individual work

Načini ocenjevanja:

Seminarska naloga
Ustni zagovor seminarske naloge

Delež (v %) /
Weight (in %)

50 %
50 %

Assessment:

Seminar work
Oral defense of seminar work

Reference nosilca / Lecturer's references:

- A. Hrovat, G. Kandus, **T. Javornik**, "A survey of radio propagation modeling for tunnels", *IEEE Communications surveys and tutorials*, vol. 16, no. 2, pp. 658-669, 2014
- 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*, ISSN 1687-1499, [in press] 2015
- T. Celcer, G. Kandus, **T. Javornik**, "Adaptive utility-based scheduling algorithm for multiuser MIMO uplink", *EURASIP Journal on wireless communications and networking*, (online), vol. 2011, no. 22, pp. 1-12, 2011, <http://jwcn.eurasipjournals.com/content/2011/1/22>
- A. Hrovat, G. Kandus, **T. Javornik**, "Four-slope channel model for path loss prediction in tunnels at 400 MHz", *IET microwaves, antennas & propagation*, vol. 4, no. 5, pp. 571-582, 2010.
- I. Jelovčan, G. Kandus, **T. Javornik**, "An adaptive zero forcing 2010, maximum likelihood soft input soft output MIMO detector", *IEICE Transactions on Communications*. vol. E92-B, no. 2, pp. 507-515. 2009