

## UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	Telekomunikacijski sistemi
<b>Course title:</b>	Telecommunication Systems

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

**Vrsta predmeta / Course type** Izbirni / Elective

**Univerzitetna koda predmeta / University course code:** IKT2-637

Predavanja Lectures	Seminar Seminar	Sem. vaje Tutorial	Lab. vaje Laboratory work	Teren. vaje Field work	Samost. delo Individ. work	ECTS
60	30			60	450	20

*\*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. Gorazd Kandus  
Prof. dr. Aleš Švigelj  
Prof. dr. Tomaž Javornik  
Prof. dr. Mihael Mohorčič  
Doc. dr. Andrej Hrovat

**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:  
definicija in pomen telekomunikacij, vrste telekomunikacijskih storitev, telekomunikacijski standardi in regulativa, osnovni model komunikacijskega sistema  
Izvirno kodiranje:  
informacija, entropija in kapaciteta kanala, kodiranje analognih in digitalnih izvorov, vzorčenje in kvantizacija  
Kanalno kodiranje:

**Content (Syllabus outline):**

Introduction:  
definition and role of telecommunications, types of telecommunication services, telecommunication standards and regulations, basic model of communication system  
Source Coding:  
information, entropy and channel capacity, analogue and digital source coding, sampling and quantization  
Channel Coding:

<p>bločno kodiranje, Hammingova razdalja, konvolucijsko kodiranje, Viterbijevo dekodiranje, FEC, kodiranje govora</p> <p>Modulacijski postopki:</p> <p>osnove modulacijskih postopkov, analogne modulacije (AM, PM, FM), digitalne modulacije (PCM, DPCM, DM, BPSK, QPSK, M-PSK, QAM, M-APSK, FSK, M-FSK, MSK, GMSK), detekcija signala, napredni kodni in modulacijski postopki</p> <p>Prenosni mediji:</p> <p>bakrene parice in kabli, optična vlakna, atmosfera</p> <p>Digitalni prenos signalov in šum:</p> <p>naključni procesi in šum, teorija odločanja in optimalni sprejem signalov, medsimbolno popačenje, drhtenje faze, izenačevanje, prepletanje</p> <p>Digitalno multipleksiranje:</p> <p>časovno razvrščanje digitalnih kanalov, asinhroni prenosni način, sinhrona digitalna hierarhija</p> <p>Digitalna omrežja:</p> <p>vodovna komutacija, paketna komutacija, ISO/OSI referenčni model, TCP/IP omrežna arhitektura, fiksno-mobilna konvergenca, omrežja naslednje generacije.</p> <p>Brezžične komunikacije:</p> <p>osnove brezžičnega prenosa, brezžična komunikacijska omrežja in storitve, mobilne, stratosferske in satelitske komunikacije</p>
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<p>block coding, Hamming distance, convolutional coding, Viterbi decoding, FEC, speech coding</p> <p>Modulation Techniques:</p> <p>fundamentals of modulation schemes, analogue modulations (AM, PM, FM), digital modulations (PCM, DPCM, DM, BPSK, QPSK, M-PSK, QAM, M-APSK) FSK, M-FSK, MSK, GMSK), signal detection, advanced coding and modulation schemes</p> <p>Transmission Media:</p> <p>copper pairs and cables, optical fibres, atmosphere</p> <p>Digital Signal Transmission and Noise:</p> <p>random processes and noise, decision theory and optimal signal reception, intersymbol interference, jitter, equalization, interleaving</p> <p>Digital Multiplexing:</p> <p>time division multiplexing, asynchronous transfer mode, synchronous digital hierarchy</p> <p>Digital Networks:</p> <p>circuit switching, packet switching, ISO/OSI reference model, TCP/IP network architecture, fixed-mobile convergence, next generation networks</p> <p>Wireless Communications:</p> <p>fundamentals of wireless communications, wireless communication networks and services, mobile, stratospheric and satellite communications</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"> <li>• R. L. Freeman, <i>Fundamentals of Telecommunications</i>, Wiley, 2005. ISBN: 978-0-471-71045-5</li> <li>• S. Haykin, <i>Digital Communication Systems</i>, Wiley, 2013. ISBN: 978-0-471-64735-5</li> <li>• C. Larsson, <i>Design of Modern Communication Networks</i>, 2014. ISBN: 978-0-124-07238-1</li> <li>• A. F. Molisch, <i>Wireless Communications</i>, Wiley, 2010. ISBN: 978-0-470-74186-3</li> <li>• G. Maral, M. Bosquet, <i>Satellite Communications Systems</i>, Wiley, 2010. ISBN: 978-0-470-71458-4</li> </ul>
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### Cilji in kompetence:

<p>Cilj predmeta je seznaniti študenta z znanji s področja telekomunikacijskih sistemov.</p> <p>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</p>
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### Objectives and competences:

<p>The aim of the course is to familiarize the student with the knowledge in the field of telecommunication systems.</p> <p>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</p>
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samokritične presoje.

over research methods, procedures and processes and a development of the critical judgment.

#### **Predvideni študijski rezultati:**

Študent, ki bo uspešno končal ta predmet, bo pridobil:

- razumevanje osnovnih fizikalnih pojavov in procesov v telekomunikacijskih sistemih
- prepoznavanje različnih vrst telekomunikacijskih omrežij ter analiziranje njihovih zmogljivosti in kapacitet, kar je osnova za uvajanje telekomunikacijskih storitev
- identificiranje zahtevanih podatkov in izbira ustreznih orodij, potrebnih za načrtovanje omrežij
- sposobnost izbire ustreznega kodno modulacijskega postopka glede na razmere v radijskem kanalu
- sposobnost izbire ustreznega algoritma za detekcijo in dekodiranje signala
- razlikovanje med različnimi brezžičnimi dostopnimi sistemi in standardi ter njihovo primernostjo glede na potrebe po obsegu pokritja, podpori mobilnosti, simetriji prenosa in izbrani arhitekturi sistema
- poznavanje satelitskih tirnic in konstelacij primernih za telekomunikacijske sisteme
- razumevanje temeljnih razlik med satelitskimi in prizemnimi komunikacijskimi sistemi

#### **Intended learning outcomes:**

Student who completes this course successfully will acquire:

- understanding of physical phenomena and processes in telecommunication systems
- identification of different types of telecommunication networks and analysis of their performances and capacities with regard to the services which they enable
- identification of required data and choice of suitable tools, needed for network design
- ability to choose the coding and modulation schemes according to conditions in radio channel
- ability to select the appropriate algorithm for decoding and detection of signal
- ability to differentiate among wireless access systems and their suitability to satisfy different requirements regarding range, mobility support, transmission symmetry and system architecture
- Knowledge of satellite orbits and constellations suitable for communication systems
- Understanding of the fundamental differences between satellite and terrestrial communication systems

#### **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:**

- 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.
- **A. Švigelj**, **M. Mohorčič**, L. Franck, **G. Kandus**, "Signalling analysis for traffic class dependent routing in packet switched ISL networks," *Space communications*, vol. 22, no. 2/4, pp. 191-203, 2013.
- **A. Švigelj**, R. Sernec, K. Alič, "Network-traffic modeling for load prediction: A user-centric approach," *IEEE Network*, vol. 29, no. 4, pp. 88 - 96, 2015.
- 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.
- M. Pesko, **T. Javornik**, A. Košir, M. Štular, **M. Mohorčič**, "Radio environment maps: the survey of construction methods," *Transactions on internet and information systems*, vol. 8, no. 11, pp. 3789-3809, 2014.

