COURSE DESCRIPTION CARD - SYLLABUS

Course name
OVERVIEW OF MODERN TELECOMMUNICATIONS TECHNIQUES [S5ITIT>PNTT]

Course

Proposed by Discipline
–

Year/Semester
2/4

Level of study
Doctoral School

Course offered in
English

Form of study
full-time

Requirements
elective

Number of hours

Lecture
8

Laboratory classes
0

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

The student should have a basic knowledge of probability, optimization and graph theories, functions and structures of telecommunication networks. He has a systematic knowledge of mathematical analysis and algebra. Additionally, student has a systematic knowledge, together with necessary mathematical background, of 1D signal theory; this knowledge allows him/her to understand the representation of signals and signal analysis in time domain and frequency domain. Student knows the principles of construction of computer programs, has knowledge from the area of computing science; knows the syntax of C, C++, C#, MatLab. He should be able to use bibliography in English (books, scientific and technical journals, application notes, catalogs, instructions, recommendations, etc.). He should also be able to communicate in English in a professional environment.

Course objective

The course aims to provide students with a comprehensive understanding of the developmental trends in modern telecommunication networks - including mobile networks, optical networks, and data center infrastructures. Particular emphasis is placed on the principles, methodologies, and tools for the design, modeling, and analysis of such networks. The goal is to familiarize students with advanced techniques of hybrid video compression. The goal is to show the complexity aspects of currently used methods and algorithms in video compression, and the problems of their implementation in practice (in video encoders and video decoders).

Course-related learning outcomes

Knowledge:
1. The student has skills associated with the state of the art compression techniques of video data. [P8S_WG/SzD_W01].

2. The student has knowledge in terms of idea of the known video compression algorithms, and is able to use the known methods for efficient representation and transmission of video data in telecommunication channel. [P8S_WG/SzD_W02].

3. The student knows advantages and disadvantages of the known video compression techniques, and understand well the benefits from using the methods for efficient representation of a video. [P8S_WG/SzD_W02].

4. The student knows and understands the architecture and structural design of data centers, including emerging development trends. [P8S_WG/SzD_W01].

5. The student knows novel communication technologies and infrastructure components used in modern data centers. [P8S_WG/SzD_W02].

6. The student knows key methods of network control, management, and security applied in data center environments. [P8S_WG/SzD_W03].

Skills:
1. The student is able to give the mathematical description of the known algorithms of video compression. [P8S_UW/SzD_U01].

2. The student is able to perform compression of a video data in order to represent them in an efficient way, and is able to do the analysis of compression performance of the method. [P8S_UW/SzD_U02].

3. Analyze and evaluate the design and functionality of data center infrastructures. [P8S_UW/SzD_U02].

4. Apply methodologies and tools for assessing network management and security mechanisms in data centers. [P8S_UW/SzD_U01].

Social competences:
1. The student understands the need for continuous training in order to improve skills. [P8S_KK/SzD_K02, P8S_KK/SzD_K03].

2. The student is aware of the ethical, environmental, and business implications of data center operations and is able to critically evaluate their own contribution to the development of modern telecommunication networks. [P8S_KK/SzD_K02].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written and/or oral exam from material presented during lectures. The grade depends on the number of points the student earns relative to the maximum number of required points. Earning more than 50% of the possible points is a prerequisite for passing. The relationship between the grade and the number of points:

<=50%; 2,0
above 50% – 60.0%: 3.0
above 60% – 70.0%: 3.5
above 70% – 80.0%: 4.0
above 80% – 90.0%: 4.5
above 90% – 100%: 5.0

Programme content

Issues related to current research challenges, emerging methodologies, and future prospects for the development of telecommunication technologies. The lectures address advanced topics such as modern image compression techniques and their role in efficient multimedia transmission, the evolution of mobile networks towards next-generation architectures, innovations in optical networking for high-capacity data transport, as well as the design and management of data center infrastructures.

Course topics

Lecture 1. Emerging technologies in visual communication (AI-based video processing, video compression standardization, immersive video, video coding for machines).

Lecture 2. Advanced video data compression (hybrid coding schemes of a video). Problems of the complexity of methods and their practical implementation.

Lectrue 3. Current research issues and development directions in optical networks: access networks, metro and backbone networks, development directions for switching nodes and systems, flexible optical networks, and spatially multiplexed networks. Key bibliographic references and journals in the field of optical networks.

Lecture 4. The lecture covers the architecture and structural design of data centers, with a focus on emerging development trends. Students will be introduced to novel communication technologies and key infrastructure components that shape modern data centers. Particular attention is given to methods of network control and management, as well as to strategies and mechanisms ensuring data center security. In addition, the course addresses the business aspects of data center operations, including cost efficiency, scalability, energy management, and service delivery models.

Teaching methods

Lectures are conducted in a traditional format and are supported by multimedia presentations, which are made available to students in advance. The presentations are supplemented with additional explanations and illustrative examples provided on the board. Selected topics are further expanded through case studies, allowing students to relate theoretical content to practical applications.

Bibliography

Basic
1. Mukherjee, B., Tomkos, I., Tornatore, M., Winzer, P., & Zhao, Y. (Eds.). (2020). Springer Handbook of Optical Networks. Cham: Springer Nature Switzerland AG. https://doi.org/https://doi.org/10.1007/978-3-030-16250-4
2. Chatterjee, B. C., & Oki, E. (2020). Elastic Optical Networks: Fundamentals, Design, Control, and Management. Elastic Optical Networks: Fundamentals, Design, Control, and Management. CRC Press. https://doi.org/10.1201/9780429465284
3. Damian Karwowski, „Zrozumieć Kompresję Obrazu”, ISBN: 978-83-953420-0-4, Poznań 2019, Wydanie pierwsze, (283 strony).
4. M. Domański, Obraz cyfrowy, WKŁ, 2011.
5. Dutt D. G. Cloud Native Data Center Networking: Architecture, Protocols, and Tools 1st Edition, ISBN-978-1492045601, O'Reilly Media, 2019

Additional
1. Sahu, P. P. (2020). Fundamentals of Optical Networks and Components. Boca, Raton, London, New York: CRC Press.
2. Chadha, D. (2019). Optical WDM networks: From static to elastic networks. Optical WDM Networks:

From Static to Elastic Networks. Wiley IEEE Press. https://doi.org/10.1002/9781119393399
3. K. Sayood, Kompresja danych – wprowadzenie, Wydawnictwo RM, 2002.
4. G. Salomon, G. Motta, Handbook of data compression, Springer-Verlag, 2010.
5. J. R. Vacca, “Cloud Computing Security: Foundations and Challenges”. CRC Press, 2016 (https://www.amazon.com/Cloud-Computing-Security-Foundations-Challenges/dp/1482260948)
6. C. Dotson, “Practical Cloud Security: A Guide for Secure Design and Deployment”, O'Reilly Media, 2019 (https://www.amazon.com/Practical-Cloud-Security-Secure-Deployment/dp/1492037516)

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	8	0,00
Doctoral student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation)	42	2,00