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230371 - FOI5GN - Fiber Optic Infrastructure for 5G Networks

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Teaching unit Optional)

ECTS credits: 2,5 Teaching languages: Spanish

Teaching staff

Coordinator: Gabriel Junyent Giralt

Others: Gabriel Junyent Giralt

Opening hours

Timetable: Any time is possible by appointment e-mail.

Degree competences to which the subject contributes

Specific:

CE1. Ability to apply information theory methods, adaptive modulation and channel coding, as well as advanced techniques of digital signal processing to communication and audiovisual systems.
CE2. Ability to develop radio-communication systems: antennas design, equipment and subsystems, channel modeling, link dimensioning and planning.
CE3. Ability to implement wired/wireless systems, in both fix and mobile communication environments.

CE4. Ability to design and dimension transport, broadcast and distribution networks for multimedia signals

CE6. Ability to model, design, implement, manage, operate, administrate and maintain networks, services and contents
CE9. Ability to deal with the convergence, interoperability and design of heterogeneous networks with local, access and core networks, as well as with service integration (telephony, data, television and interactive services).
CE13. Ability to apply advanced knowledge in photonics, optoelectronics and high-frequency electronic

CE15. Ability to integrate Telecommunication Engineering technologies and systems, as a generalist, and in broader and multidisciplinary contexts, such as bioengineering, photovoltaic conversion, nanotechnology and telemedicine.

Transversal:

CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

Teaching methodology

Lectures (4h/week).
Final Exam (type test and short questions).

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Learning objectives of the subject

The 5th generation of the mobile communication system (5G) is expected to change the landscape of communication by the year 2020. 5G technology will provide a unified platform to connect billions of devices and offer a wide range of network services. The fiber optic transport network must adopt solutions that meet the quality of service requirements, as foreseen in 5G. Optical transport technology is perceived as a key provider for radio access networks (RANs) due to its high capacity and low transmission delay (latency). In practice, the performance objectives foreseen in 5G will depend on the availability of optical fiber in the RAN-5G networks.
The Fronthaul network is the RAN responsible for connecting the remote radio units (RRU) of the base stations (BS) with central offices (CO) of the Mobile Network Operators, which in turn are connected to the metro-core transport network, Backhaul network, to be able to provide IP connectivity. The baseband units (BBU) located in the COs will perform all the processing of the digital radio signals over fiber (DRoF) from the RRUs, to convert said downstream signals into Internet Protocol (IP) traffic. The BBUs will also perform the same operations but in reverse order for the DRoF upward signals to the RRUs.

The main objective of this seminar is to train students in the methods of study, analysis and evaluation of fiber optic transmission technologies to implement the transport of DRoF signals through Fronthaul access networks (RAN-5G). This will address the transmission formats of the DRoF signals, topologies and transmission systems of the RAN-5G and Backhaul (for connection to the IP network and implemented by Automatically Switched Optical Network technology) networks, as well as their future evolutions.

Learning results of the subject:
- Ability to analyse, specify, design networks, services, processes and applications of telecommunications in local or long distance, with different bandwidths through fiber optical access networks (RAN-5G).
- Ability to apply engineering tools as planning tools, dimensioning and optical network analysis. through access networks (RAN-5G).
- Ability to analyse, model and implement new architectures, network protocols and communication interfaces, and new services and applications in optical networks through access networks (RAN-5G).

Study load

Total learning time: 62h 30m	Hours large group:	20h	32.00%
	Self study:	42h 30m	68.00%

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Content

I-Optical Fiber Technologies for Radio Access Networks (RAN)

Learning time: 12h
Theory classes: 4h
Self study : 8h

Description:
I.1- Evolution of Radio Access Networks (RAN)
I.2- Transmission formats for Fronthaul-RAN
I.3- Topologies for 5G Fronthaul-RAN
I.4- Evolution towards 5G Ultra-Dense Networks (5G-UDN)

II-Digital Transmission for Fronthaul-RAN

Learning time: 13h
Theory classes: 4h
Self study : 9h

Description:
II.1- Types, characteristics and benefits of Optical Fibers
II.2- Digital Transmission with Intensity Modulation (MI) and Direct Detection (DD)
II.3- Transceivers and Transpondes for MI-DD
II.4- MI-DD Transmission Systems for Fronthaul-RAN

III- Transmission Systems with Dense Multiplexing by Wavelength (Dense Wavelength Division Multiplexing, DWDM) for Fronthaul-RAN

Learning time: 13h
Theory classes: 4h
Self study : 9h

Description:
III.1- Introduction to DWDM
III.2- Transceivers and Transponders DWDM
III.3- DWDM Systems for Fronthaul-RAN
III.4- Evolution of the DWDM technology: Elastic Optical Networks (flex grid WDM)

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IV- Coarse-WDM Transmission Systems for Fronthaul-RAN	Learning time: 10h Theory classes: 3h Self study : 7h

Description:
IV.1- Introduction to CWDM ("low-cost WDM")
IV.2- Transceivers and Transponders CWDM
IV.3- CWDM systems for Fronthaul-RAN

V- Fronthaul and Backhaul Optical Networks	Learning time: 14h 30m Theory classes: 5h Self study : 9h 30m

Description:
V.1- Fronthaul Networks Point to Point (P2P)
V.2- Fronthaul WDM networks with OADM rings
V.3- Fronthaul Networks WDM-Mesh
V.4- Protection and Monitoring of Fronthaul Networks
V.5- Backhaul Networks
V.6.-Ultradense cellular networks 5G (5G-UDN)

Qualification system

Final Exam (type test and short questions).

Regulations for carrying out activities

On the final exam students will be able to bring all kinds of technical information (slides, books, related papers of the seminar, etc.)

Bibliography

Complementary:

Keiser, G. Optical fiber communications. 5th ed. New York: McGraw-Hill, 2013. ISBN 9781259006876.

Stavdas, A. Core and metro networks [on line]. Chichester, West Sussex: John Wiley & Sons Ltd, 2010 [Consultation: 26/09/2018]. Available on: <https://onlinelibrary.wiley.com/doi/book/10.1002/9780470683576>. ISBN 9780470512746.

Chomycz, B. Planning fiber optics networks. New York: McGraw-Hill, 2009. ISBN 9780071499194.

Others resources:

For this seminar ATENEA will be the virtual teaching support tool. From there the students will be able to download all the documents (pdf, slides, related papers, etc.) of the seminar.