



Course guides

230371 - FOI5GN - Fiber Optic Infrastructure for 5G Networks

Last modified: 06/05/2019

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

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

Academic year: 2019 **ECTS Credits:** 2.5 **Languages:** Spanish

LECTURER

Coordinating lecturer: Gabriel Junyent Giralt

Others: Gabriel Junyent Giralt

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).

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

Type	Hours	Percentage
Hours large group	20,0	32.00
Self study	42,5	68.00

Total learning time: 62.5 h

CONTENTS

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

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)

Full-or-part-time: 12h

- Theory classes: 4h
- Self study : 8h



II-Digital Transmission for Fronthaul-RAN

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 Transponders for MI-DD
- II.4- MI-DD Transmission Systems for Fronthaul-RAN

Full-or-part-time: 13h

Theory classes: 4h

Self study : 9h

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

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)

Full-or-part-time: 13h

Theory classes: 4h

Self study : 9h

IV- Coarse-WDM Transmission Systems for Fronthaul-RAN

Description:

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

Full-or-part-time: 10h

Theory classes: 3h

Self study : 7h

V- Fronthaul and Backhaul Optical Networks

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)

Full-or-part-time: 14h 30m

Theory classes: 5h

Self study : 9h 30m

GRADING SYSTEM

Final Exam (type test and short questions).



EXAMINATION RULES.

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:

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

RESOURCES

Other 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.