



Course guides

230631 - OFT - Optical Fiber Telecommunications

Last modified: 09/06/2020

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).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).

Academic year: 2020 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Comellas Colomé, Jaume

Others: Jaume Comellas Colomé
Joan M, Gené Bernaus

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

3. Ability to implement wired/wireless systems, in both fix and mobile communication environments.
4. Ability to design and dimension transport, broadcast and distribution networks for multimedia signals

Transversal:

1. 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.
2. 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 (3h/week)
Group work or Individual work : Technical Report
Oral presentations of Technical Reports
Other activities
Extended answer test (Final Exam)

LEARNING OBJECTIVES OF THE SUBJECT

The objective of this course is to train students in the methods of study, analysis, design and evaluation of optical fiber communication technologies.

First, we will analyze the great evolution in the main technologies related to fiber optics, and key devices to build transmission systems.

Next, we will analyze and evaluate the optical switching technologies of the transport plane of Automatically Switched Optical Networks (ASON), and the main optical fiber transmission technologies that currently allow the implementation of IP-DWDM transport networks, as well as its likely future evolution.

We also briefly discuss the important contribution that fiber optic transmission technology will have on the future evolution of radio access networks (Fronthaul) for the future 5G mobile technology.

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 in IP over fiber optical networks.
- Ability to apply engineering tools as planning tools, dimensioning and optical network analysis.
- Ability to analyse, model and implement new architectures, network protocols and communication interfaces, and new services and applications in optical networks.

STUDY LOAD

Type	Hours	Percentage
Hours large group	39,0	31.20
Self study	86,0	68.80

Total learning time: 125 h

CONTENTS

1. Evolution of Optical Fiber Telecommunication Technology.

Description:

- Evolution of optical fibers.
- Evolution of transmission systems with optical channel multiplexing.
- Evolution of optical spectral efficiency of transmission systems.
- Evolution of optical switching and signal processing.
- Evolution to new markets:
 - "The new cloud era with Data Centers".
 - Fiber Optic Infrastructure for 5G Mobile.
 - Fiber Optic Technology for Smart Cities.

Full-or-part-time: 10h

Theory classes: 4h

Self study : 6h



2. Key devices for optical fiber transmission systems.

Description:

Optical fibers: types, characteristics and performances.

Fiber optic propagation:

- Dispersions.
- Non lineal effects.

Optical multiplexers and demultiplexers.

Optical amplifiers:

- Erbium Doped Fiber optic Amplifier (EDFA).
- RAMAN: distributed optical amplifier.

Full-or-part-time: 16h 30m

Theory classes: 9h

Self study : 7h 30m

3. Fiber Optic Transmission Systems.

Description:

Modulation of Intensity and Direct Detection.

Coherent Systems with Heterodyne Detection.

Advanced Modulation Formats.

Dense Wavelength Division Multiplexing (DWDM).

Coarse Wavelength Division Division Multiplexing (CWDM).

Optical transceivers and transponders.

Full-or-part-time: 23h 30m

Theory classes: 10h 30m

Self study : 13h

4. Optical switching.

Description:

Optical switches.

Optical Add Drop Multiplexer (OADM).

Reconfigurable OADM (ROADM).

Multi-degree ROADM.

Full-or-part-time: 18h

Theory classes: 8h

Self study : 10h



5. IP Transport in Optical Networks.

Description:

OTN technology.

Forward Error Control (FEC) technologies.

IP transmission based on technologies: Ethernet + OTN + FEC + DWDM with tunable laser + Optical amplifiers + M-ROADM + Control Plane.

Automatically Switched Optical Networks (ASON).

Metro and Core Networks.

Future evolution:

- Elastic Technologies with FlexGrid-WDM.
- Transponders for high speeds ≥ 400 Gbps.
- New modulation technologies: OFDM and Nyquist.
- Superchannels with optical multicarriers for transmissions at terabits.
- Spatial multiplexing (SDM) with multi-core fibers.
- Modal multiplexing with Few-Mode Fibers (FMF).
- Software Defined Networking and Network Functions Virtualization.

Full-or-part-time: 19h

Theory classes: 8h

Self study : 11h

6. Fiber Optic Infrastructures to implement 5G Mobile

Description:

Fiber optic technologies for Radio Access Networks (RAN): The path to 5G requires a strong optical network.

Transport CPRI over: Ethernet or OTN Mapping.

C-RAN: Fronthaul and Backhaul Networks.

Full-or-part-time: 13h 40m

Theory classes: 5h 40m

Self study : 8h

ACTIVITIES

TECHNICAL REPORT

Description:

Technical Report: This activity involves the preparation of a Technical Work, individual or in group of 2 students, which must be delivered in PowerPoint format and presented to the class at the end of the course.

Oral Presentation: Oral presentation of Technical Report (30 minutes)

Final exam (90 minutes)

Specific objectives:

Evaluate technical research carried out individually or in groups on a topic related to the course.

Material:

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

Delivery:

Technical Report: 1 week before the end of course

Full-or-part-time: 29h

Self study: 29h



ORAL PRESENTATION

Description:

Technical Report Presentation of a work group

Specific objectives:

To evaluate the ability to present oral in group and individually results of the technical report

Material:

Power point presentation

Full-or-part-time: 0h 45m

Laboratory classes: 0h 45m

FINAL EXAM

Description:

Final exam

Full-or-part-time: 1h 30m

Theory classes: 1h 30m

GRADING SYSTEM

Final examination: 40%

Individual assessment: 10%

Group assessments: 50% ("Technical Report": work-technical report on a topic related to the subject)

EXAMINATION RULES.

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

BIBLIOGRAPHY

Basic:

- Alexandros Stavdas. Core and Metro Networks [on line]. Wiley, 2010 [Consultation: 17/07/2017]. Available on: <http://onlinelibrary.wiley.com/book/10.1002/9780470683576>. ISBN 9780470512746.
- Binh, L.N. Advanced digital optical communications [on line]. 2nd. ed. Boca Raton, FL: CRC Press, 2015 [Consultation: 01/04/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1752752>. ISBN 9781482226539.
- Kaminow, I.P.; Li, T.; Willner, A.E. Optical fiber telecommunications VI A: components and subsystems [on line]. 6th ed. San Diego [etc]: Academic Press, 2013 [Consultation: 20/04/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1187142>. ISBN 9780123972354 (VOL. A).
- Kaminow, I.P.; Li, T.; Willner, A.E. Optical fiber telecommunications, VI B: systems and networks [on line]. 6th ed. San Diego [etc]: Academic Press, 2013 [Consultation: 20/04/2020]. Available on: <https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1190987>. ISBN 9780123972378 (VOL. B).

Complementary:

- Chesnoy, J. Undersea fiber communication systems [on line]. 2nd. ed. Amsterdam: Academic Press, 2015 [Consultation: 19/06/2017]. Available on: <http://www.sciencedirect.com/science/book/9780128042694>. ISBN 9780128043950.
- Keiser, G. Optical fiber communications. 5th ed. New York: McGraw-Hill, 2013. ISBN 9781259006876.
- Chomycz, B. Planning Fiber Optic Networks. McGraw-Hill, 2009. ISBN 0071499199.
- Mukherjee, B. Optical WDM networks. New York: Springer, 2006. ISBN 0387290559.
- Hui, R.; O'Sullivan, M. Fiber optic measurement techniques. Burlington, MA: Academic Press/Elsevier, 2009. ISBN 9780123738653.



- Chan, C.C.K. Optical performance monitoring: advanced techniques for next-generation photonic networks. Amsterdam ; Boston: Academic Press, 2010. ISBN 9780123749505.

RESOURCES

Hyperlink:

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