

230631 - OFT - Optical Fiber Telecommunications

Coordinating unit:	230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit:	739 - TSC - Department of Signal Theory and Communications
Academic year:	2017
Degree:	DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 1992). (Teaching unit Optional) DEGREE IN ELECTRONIC ENGINEERING (Syllabus 1992). (Teaching unit Optional) MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional) MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Teaching unit Optional) MASTER'S DEGREE IN NETWORK ENGINEERING (Syllabus 2009). (Teaching unit Optional) MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2009). (Teaching unit Optional) MASTER'S DEGREE IN INFORMATION AND COMMUNICATION TECHNOLOGIES (Syllabus 2009). (Teaching unit Optional)
ECTS credits:	5
Teaching languages:	English

Teaching staff

Coordinator:	GABRIEL JUNYENT GIRALT
Others:	Junyent Giralt, Gabriel

Opening hours

Timetable:	Any time is possible by appointment email
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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 (distance): Technical Report
Oral presentations
Other activities
Extended answer test (Final Exam)

Learning objectives of the subject

The aim of this course is to train students in the methods of study, analysis, design and evaluation of existing telecommunications technologies for optical fiber. First, we will analyze the great evolution in the main technologies

230631 - OFT - Optical Fiber Telecommunications

related to digital fiber optic transmission, especially DWDM, the devices and key components, and optical switching subsystems for DWDM networks. A very important aspect is the chapter devoted to the transceiver (transmitter & receiver) for the classical systems of intensity modulation, and high speed coherent systems that incorporate very high speed DSP. The trend towards compact transceivers (pluggables) is greatly facilitating the development and manufacture of transmission systems for implementing the optical networks, especially for DWDM and Data Centers. Finally, we will analyze and evaluate the technologies that currently allow the implementation of IP-DWDM optical transport networks, as well as its likely future evolution. We also briefly discuss the important contribution that the optical transmission technology will have on the future evolution of radio access networks (Fronthaul) for 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

Total learning time: 125h	Hours large group:	39h	31.20%
	Hours medium group:	0h	0.00%
	Hours small group:	0h	0.00%
	Guided activities:	0h	0.00%
	Self study:	86h	68.80%

230631 - OFT - Optical Fiber Telecommunications

Content

<p>1. Evolution of Optical Fiber Telecommunications.</p>	<p>Learning time: 10h Theory classes: 4h Self study : 6h</p>
<p>Description:</p> <ul style="list-style-type: none"> Evolution of multimode and single mode optical fibers. Evolution of transmission systems: intensity modulation and direct detection to coherent systems. Evolution of transmission systems with optical channel multiplexing. Evolution of digital (electronic) processing in coherent systems. Evolution of transmission systems for optical channels speeds ? 100Gbps. Evolution of spectral efficiency of transmission systems. Evolution of switching and optical processing systems. Evolution in the development of optical networks. Evolution of systems for monitoring, control and management of optical networks. Evolution of optic networks for "the new cloud era". Evolution of access networks: FTTx and Fronthaul (Radio Access Network, RAN). 	
<p>2. Fiber Optic Digital Transmission Systems.</p>	<p>Learning time: 23h 30m Theory classes: 10h 30m Self study : 13h</p>
<p>Description:</p> <ul style="list-style-type: none"> Analysis, characteristics and performance of the current Digital Transmission Technologies by Fiber Optic: -Modulation of Intensity and Direct Detection. -Coherent Systems with Heterodyne Detection: Modulation Formats. -Transmission Systems with Wavelength Division Multiplexing (WDM). -Transmission Systems with Dense Wavelength Multiplexing by Division (DWDM). -Low-cost transmission systems with Coarse Wavelength Division Multiplexing (CWDM). -Low-cost WDM systems with Wideband-Multimode Fiber in the first window. -Evolution of WDM technology: Flexible WDM and optical Superchannels. -Metropolitan Networks. -Core Networks. -Cloud Radio Access Networks (C-RAN). 	

230631 - OFT - Optical Fiber Telecommunications

<p>3. Key devices and components for optical fiber digital transmission systems.</p>	<p>Learning time: 16h 30m Theory classes: 7h 30m Self study : 9h</p>
<p>Description:</p> <p>Optical fibers: types, characteristics and performances. Dispersions in optical fibers: types, characteristics, transmission-degradation and their compensation. Optical filters: types, analysis and performances. Optical multiplexers and demultiplexers: types, analyzes and performances. Erbium Doped Fiber optic Amplifier (EDFA): types, analysis, performances and applications. RAMAN distributed optical amplifier: analysis, performances and applications. Semiconductor optical amplifier: analysis, performances and applications. Components and subsystems for monitoring signals: optical and digital.</p>	
<p>4. Optical switching: Devices, components and subsystems.</p>	<p>Learning time: 18h Theory classes: 8h Self study : 10h</p>
<p>Description:</p> <p>Optical switches: types, features and performance. Wavelength switching: technologies, features and performances. Optical channel switching: technologies, features and performances. Optical Add Drop Multiplexer (OADM) Subsystems. Reconfigurable Subsystems OADM (ROADM): technologies, types and performances. ROADM subsystem for nodes multidegree: M-Degree ROADM. Multi-degree optical switching nodes: types, technologies and performances.</p>	

230631 - OFT - Optical Fiber Telecommunications

5. Optical Transceivers.

Learning time: 19h

Theory classes: 8h

Self study : 11h

Description:

Optical transmitters and receivers for current intensity modulation and direct detection (IM-DD).

IM-DD transceiver: transmitter + receiver.

Pluggable IM-DD transceivers: types and applications.

SFP (small form-factor pluggable) Transceivers: applications and features.

XFP (X-factor pluggable) transceivers: applications and features.

Optical transmitters for coherent systems: modulation formats and block diagram.

Optical transmitters for 100 Gbps DP-QPSK (Diversity optical Polarization,DP) for DWDM systems.

Optical DP-MQAM transmitters for ? 100 Gbps coherent systems for DWDM systems.

Optical receivers for coherent systems with heterodyne detection: block diagram, analysis and performances.

Pluggable Transceivers for Coherent Systems.

Pluggable Transceivers for Data Centers.

Reconfigurable transceivers (modulation formats and velocity) for coherent systems DSP for coherent systems: performance and applications.

DSP for coherent systems: performances and applications.

Modules transponders with: transceivers for user connection + transceivers for connection to network of transport + digital processing, etc.

230631 - OFT - Optical Fiber Telecommunications

6. IP Transport in Optical Networks: Current Technologies and Future Evolution.

Learning time: 13h 40m

Theory classes: 5h 40m

Self study : 8h

Description:

OTN transport format: Features and benefits.

OTN technology for multiplexing-demultiplexing of digital channels.

New developments in optical transport networks (OTN)

Digital Signal Processing using FPGAs

FEC technologies for the detection and correction of errors.

Transponder modules (transmitters + receivers) for IP transmission based on technologies: Ethernet + OTN + FEC + transceivers DWDM with tunable laser + Optical amplifiers + M-ROADM + optical and digital signal monitoring + Control plane (control and control)

Current technologies: DWDM transport technologies with fixed 50GHz channels with tunable and reconfigurable transponders for speeds up to approximately 100-200 Gbps per optical channel.

Future developments (see AFOC):

Elastic Technologies with WDM FlexGrid

Transponders for high speeds: ? 400Gbps

New modulation technologies: OFDM and Nyquist

Superchannels: transponders with optical multicarriers for transmissions at speeds > terabits with high spectral efficiency.

Technologies for high capacity transmission using spatial multiplexing (SDM) with multi-core (multicore) optical fibers.

Technologies for high-capacity transmission using modal multiplexing with Few-Mode Fiber (FMF) optical fibers and MI-MO technologies.

Optical transport networks based on technologies Defined Networking-Network Functions Virtualization (SDN-NFV).

Etc.

230631 - OFT - Optical Fiber Telecommunications

Planning of activities

<p>TECHNICAL REPORT</p>	<p>Hours: 29h Self study: 29h</p>
<p>Description: Technical Report: This activity involves the preparation of a Technical Work, in groups of 2 or 3 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) Oral presentation of Technical Report (30minuts) Final Exam (90 minuts)</p> <p>Support materials: 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.) related to the course.</p> <p>Descriptions of the assignments due and their relation to the assessment: Technical Report:3 week before the end of course</p> <p>Specific objectives: Evaluate technical research done in group on a subject related to the course.</p>	
<p>ORAL PRESENTATION</p>	<p>Hours: 0h 45m Laboratory classes: 0h 45m</p>
<p>Description: Technical Report Presentation of a work group</p> <p>Support materials: Power point presentation</p> <p>Specific objectives: To evaluate the ability to present oral in group and individually results of the technical report</p>	
<p>FINAL EXAM</p>	<p>Hours: 1h 30m Theory classes: 1h 30m</p>
<p>Description: Final exam</p>	

Qualification system

Final examination: 40%
 Individual assessment: 10%
 Group assessments: 50% ("Technical Report", group technical work)

230631 - OFT - Optical Fiber Telecommunications

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 course, etc.)

Bibliography

Basic:

Kaminow, I.P.; Li, T.; Willner, A.E. Optics and photonics: optical fiber telecommunications VI A: components and subsystems [on line]. 6th ed. St. Louis, MO: Academic Press, 2013 Available on:
<<http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10698605>>. ISBN 9780123972354 (VOL. A).

Kaminow, I.P.; Li, T.; Willner, A.E. Optics and photonics: optical fiber telecommunications, VI B: systems and networks [on line]. 6th ed. St. Louis, MO: Academic Press, 2013 Available on:
<<http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10713017>>. ISBN 9780123972378 (VOL. B).

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: 19/06/2017]. Available on:
<<http://site.ebrary.com/recursos.biblioteca.upc.edu/lib/upcatalunya/detail.action?docID=11022992>>. ISBN 9781482226539.

Complementary:

Mukherjee, B. Optical WDM networks. New York: Springer, 2006. ISBN 0387290559.

Ramaswami, R.; Sivarajan, K.N.; Sasaki, G.H. Optical networks: a practical perspective [on line]. 3rd ed. San Francisco: Morgan Kaufmann, 2010 [Consultation: 31/07/2013]. Available on:
<<http://www.sciencedirect.com/science/book/9780123740922>>. ISBN 9780123740922.

Desurvire, E. Wiley survival guide in global telecommunications: broadband access, optical components and networks, and cryptography. Hoboken, NJ: John Wiley & Sons, 2004. ISBN 0471675202.

Keiser, G. Optical fiber communications. 4th ed. New York: McGraw-Hill, 2011. ISBN 9780073380711.

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.

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.

Kartalopoulos, S. V. DWDM : networks, devices, and technology. First. Piscataway; Hoboken: IEEE Press; Wiley-Interscience, 2003. ISBN 0471269050.

Chomyczc, B. Planning Fiber Optic Networks. McGraw-Hill, 2009. ISBN 0071499199.

Others resources:

Hyperlink

Nom recurs

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