32115 - OFT - Optical Fibre Telecommunications

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications
Academic year: 2015
Degree: ERASMUS MUNDUS MASTER'S DEGREE IN RESEARCH ON INFORMATION AND COMMUNICATION TECHNOLOGIES (Syllabus 2009). (Teaching unit Optional)
ECTS credits: 6
Teaching languages: English

Coordinators: GABRIEL JUNYENT GIRALT
Others: JOSEP SOLÉ-PARETA, JAUME COMELLAS COLOMÉ

Degree competences to which the subject contributes

Specific:
1. Ability to implement wired/wireless systems, in both fix and mobile communication environments.
2. 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
Group work (distance)
Individual work (distance)
Oral presentations
Other activities
Extended answer test (Final Exam)

Learning objectives of the subject

Learning objectives of the subject:
The aim of this course is to train students in methods of analysis, design and evaluation of technologies for Optical Fiber Telecommunications. First, we consider the main elements of optical network transmission systems, with special focus on the evolution of DWDM (fixed grid to gridless) very high bit rate networks. Then, different technologies of current as well as future IP/WDM networks and the role of optical technologies for the cloud era are reviewed.

Learning results of the subject:

- Ability to analyse, specify, design networks, services, processes and applications of telecommunications in fixed, local or long distance, with different bandwidths in IP over Optical Networks.
- Ability to apply both traffic engineering tools as planning tools, dimensioning and network analysis.
- Ability to analyse, model and implement new architectures, network protocols and communication interfaces and new
network services and applications.

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<tr>
<th>Study load</th>
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<tbody>
<tr>
<td><strong>Total learning time</strong>: 125h</td>
<td>Hours large group:</td>
<td>39h</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>86h</td>
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# 32115 - OFT - Optical Fibre Telecommunications

## Content

| 1. Introduction | Learning time: **12h**  
|                 | Theory classes: 4h  
|                 | Self study: 8h |

**Description:**
- Optical fiber communications evolution:
  - From Multi-Mode Fiber (MMF) to Single Mode Fiber (SMF)
  - From SMF to Multi-Core Fiber (MCF)
  - From SMF to Few-Mode Fiber (FMF)
  - From Intensity Modulation to Coherent Systems
  - From Single Optical Channel Transmission to Dense Wavelength Division Multiplexing (DWDM) WDM and Space Division Multiplexing (SDM)
  - From DWDM single channel (lambda) to Superchannel
  - From Point to Point Optical Fiber Transmission to Optical Networks
  - Optical and higher layers are converging with SDN
  - Optical fibre telecommunications-networks for the cloud age

| 2. Optical Fiber Transmission Technologies | Learning time: **20h**  
|                                          | Theory classes: 6h  
|                                          | Self study: 14h |

**Description:**
- Optical Fiber Transmission Technologies:
  - Intensity Modulation and Direct Detection
  - Coherent Transmission with Heterodyne Detection
  - WDM
  - DWDM
  - CWDM
  - Superchannels
  - SDM
  - Metropolitan Networks
  - Core Networks
### 3. Key Devices, Components and Subsystems for optical fiber telecommunication

**Description:**
Key Devices, Components and Subsystems for optical fiber telecommunications:
- Optical fibers: physical impairments and compensations
- Transceivers: transmitters+receivers
- Pluggable optics for transceivers
- Optical filters
- Optical Multiplexer and Demultiplexer
- Optical amplifiers
- Reconfigurable Optical Add-Drop Multiplexers (ROADM): Evolution and technologies
- Multidegree ROADM
- Optical Switchers
- Subsystems for Optical Signal Monitoring and Digital Signal Monitoring
- Digital Signal Processing by FPGAs
- Photonic Integrated Circuits (PIC)

**Learning time:** 20h
- Theory classes: 6h
- Self study: 14h

### 4. Evolution of Optical Fibre Telecommunication Technologies

**Description:**
Evolution of Optical Fibre telecommunication Technologies:
- New developments in Optical Transport Networking (OTN)
- Ethernet+OTU (FEC)+Tunable transponders+ROADM+Control Plane
- Forward Error Technologies (FEC)
- Evolution of Transport Plane: from fixed grid to elastic or gridless technologies
- WDM Flexgrid
- Advanced Multi-degree ROADM Architectures
- Future Flexible Optical Node
- Advanced Modulation Formats- Coherent Systems
- Technologies for 100G and beyond
- OFDM
- Superchannel Technologies: toward terabit linecards
- An optical transmitter for every need
- Transponders: Bandwidth Variable Transponders with reconfigurable modulation format
- Technologies for high capacity transmission using SDM and FMFs

**Learning time:** 25h
- Theory classes: 8h
- Self study: 17h
### 5. Transporting IP traffic over optical networks

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<tr>
<th>Description:</th>
<th>Learning time: 28h</th>
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<tbody>
<tr>
<td>Transporting IP traffic over optical networks:</td>
<td>Theory classes: 9h</td>
</tr>
<tr>
<td>IP/GbE/WDM</td>
<td>Self study: 19h</td>
</tr>
<tr>
<td>Optical Networks: IP/OTN, IP/ASON, GMPLS</td>
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<td>Optical burst and packet switching Evolution to SDN networks</td>
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### 6. Optical Tecnologies for Cloud Era

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<tr>
<th>Description:</th>
<th>Learning time: 20h</th>
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<tbody>
<tr>
<td>Optical Tecnologies for Cloud era:</td>
<td>Theory classes: 6h</td>
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<tr>
<td>Cloud Computing: Transforming Information Technology</td>
<td>Self study: 14h</td>
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<tr>
<td>Software Defined Networks (SDN)</td>
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<tr>
<td>What is OpenFlow?</td>
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<td>How SDN will alter optical transport</td>
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<td>Network Funtions Virtualization</td>
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<td>Transformation to virtual-network infrastructures</td>
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<td>Optical tecnologies trends for clouds datacenters: transitioning from cooper to fiber</td>
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<td>Intra and inter Data Center Interconnections</td>
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<td>Carrier SDN: drivers and evolution</td>
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# Planning of activities

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<tr>
<th>EXERCISES</th>
<th>Hours: 13h</th>
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<td><strong>Description:</strong></td>
<td>Laboratory classes: 13h</td>
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<tr>
<td>Exercises to strengthen the theoretical knowledge.</td>
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<tr>
<td>Technical Report:</td>
<td>This activity will consist of preparing a Technical work, in groups of 2 or 3 students, which will have to be presented to the rest of the class at the end of the course.</td>
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<td><strong>Support materials:</strong></td>
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<tr>
<td>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.</td>
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## ORAL PRESENTATION

**Description:**
Presentation of a work group.

## EXTENDED ANSWER TEST (FINAL EXAMINATION)

**Description:**
Final examination.

## Qualification system

- Final examination: 40%
- Individual assessments: 10%
- Group assessments: 50% (group technical work-report)

## 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:


Complementary:


Others resources:

Hyperlink

ATENEA

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.