230613 - AFOC - Advanced Fiber Optical Communications

**Coordinating unit:** 230 - ETSETB - Barcelona School of Telecommunications Engineering
**Teaching unit:** 739 - TSC - Department of Signal Theory and Communications
**Academic year:** 2020
**Degree:** MASTER’S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Teaching unit Optional)
MASTER’S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Teaching unit Optional)
**ECTS credits:** 5
**Teaching languages:** English

### Teaching staff

**Coordinator:** JOAN M. GENÉ
**Others:** JOSÉ A. LÁZARO, JAUME COMELLAS, JOSEP PRAT

### Prior skills

Basic background on fiber-optic communications and digital communications

### Degree competences to which the subject contributes

**Specific:**

1. Ability to apply advanced knowledge in photonics, optoelectronics and high-frequency electronic
2. Ability to design and dimension transport, broadcast and distribution networks for multimedia signals
3. Ability to develop, direct, coordinate, and technical and financial management of projects in the field of: telecommunication systems, networks, infrastructures and services, including the supervision and coordination of other's subprojects; common telecommunications infrastructures in buildings or residential areas, including digital home projects; telecommunication infrastructures in transport and environment; with corresponding energy supply facilities and assessment of electromagnetic emissions and electromagnetic compatibility.
4. Ability to implement wired/wireless systems, in both fix and mobile communication environments.
5. Ability to plan networks and decision-making about services and applications taking into account: quality of service, operational and direct costs, implementation plan, supervision, security processes, scalability and maintenance. Ability to manage and assure the quality during the development process

**Transversal:**

6. 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.
7. 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
- Laboratory practical work
- Individual work (distance)
- Exercises
- Short answer test (Control)
- Extended answer test (Final Exam)
Learning objectives of the subject:

The aim of this course is to train students in methods of analysis, design, dimensioning and performance evaluation of optical fibre based communications systems. First, we consider the parameters of interest for systems planning using different photonic technologies as well as advanced optical signal processing models. Then, using this knowledge, we will study the design and evaluation of modern optical fibre based communication systems.

Learning results of the subject:

- Ability to dimension and design WDM high bit-rate fibre optic communication systems.
- Ability to analyse, model and implement advanced optical communication systems.
- Ability to use optical communications simulation tools to assess the results obtained from theoretical studies.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 125h</th>
<th>Hours large group: 26h 20.80%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h 0.00%</td>
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<tr>
<td></td>
<td>Hours small group: 13h 10.40%</td>
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<td></td>
<td>Guided activities: 0h 0.00%</td>
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<tr>
<td></td>
<td>Self study: 86h 68.80%</td>
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</tbody>
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## Content

### 1. Introduction

<table>
<thead>
<tr>
<th><strong>Description:</strong></th>
<th><strong>Learning time:</strong> 11h</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Historical evolution of optical fibre communications</td>
<td>Theory classes: 2h</td>
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<tr>
<td>- State of the art</td>
<td>Self study: 9h</td>
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### 2. WDM fundamentals

<table>
<thead>
<tr>
<th><strong>Description:</strong></th>
<th><strong>Learning time:</strong> 32h</th>
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</thead>
<tbody>
<tr>
<td>- Optical devices for WDM communications</td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>- Long haul and metro WDM systems</td>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td>- WDM systems analysis, design and performance evaluation</td>
<td>Self study: 22h</td>
</tr>
</tbody>
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### 3. Advanced Optical amplification

<table>
<thead>
<tr>
<th><strong>Description:</strong></th>
<th><strong>Learning time:</strong> 27h</th>
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<tbody>
<tr>
<td>- Doped Fiber Amplifiers</td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>- Semiconductor Optical Amplifiers</td>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td>- Raman Amplifiers</td>
<td>Self study: 18h</td>
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<tr>
<td>- Optical amplification in WDM communication systems</td>
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</tbody>
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### 4. Optical fibre propagation effects

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<tr>
<th><strong>Description:</strong></th>
<th><strong>Learning time:</strong> 28h</th>
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</thead>
<tbody>
<tr>
<td>- Chromatic and Polarization Mode Dispersion</td>
<td>Theory classes: 6h</td>
</tr>
<tr>
<td>- Non-linear effects in optical fibres</td>
<td>Laboratory classes: 3h</td>
</tr>
<tr>
<td>- Compensation (optically and electrically) of propagation effects.</td>
<td>Self study: 19h</td>
</tr>
</tbody>
</table>
### 5. Advanced modulation formats for optical communications

**Description:**
- Advanced multiplexing (wavelength, time, polarization, code...)
- Single carrier advanced formats (QPSK, m-QAM, OFDM)
- Multi-carrier formats (O-OFDM, Nyquist-WDM)
- Systems analysis and evaluation

**Learning time:** 27h
- Theory classes: 6h
- Laboratory classes: 3h
- Self study: 18h

### Planning of activities

#### LABORATORY

**Hours:** 10h
- Laboratory classes: 10h

**Description:**
Design and evaluation of WDM systems using Matlab.

#### EXERCISES

**Description:**
Exercises to strengthen the theoretical knowledge.

#### SHORT ANSWER TEST (CONTROL)

**Description:**
Mid term control.

#### SHORT ANSWER TEST (TEST)

**Description:**
Partial evaluation test with theoretical questions and short exercises.

#### EXTENDED ANSWER TEST (FINAL EXAMINATION)

**Description:**
Final examination.
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Qualification system

Final exam: 40%
Partial exams: 20%
Individual assignments: 15%
Group assignments: 25%

Bibliography

Basic:


Complementary: