Course guide
230613 - AFOC - Advanced Fiber Optical Communications

Last modified: 25/05/2023

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

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

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: JOAN MANUEL GENE BERNAUS

Others: Segon quadrimestre:
JOAN MANUEL GENE BERNAUS - 31

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
- Matlab coding
- Scientific reports
- Oral presentations
- Short answer test

LEARNING OBJECTIVES OF THE SUBJECT

The aim of this course is to train students in methods of analysis, design, dimensioning and performance evaluation of modern fiber-optic communication systems.

The expected learning results of the subject are:

- Ability to design and implement state-of-the-art fiber-optic communication systems.
- Ability to analyze and model the building blocks of modern fiber-optic networks.
- Ability to evaluate the performance of advanced fiber-optic technologies.

STUDY LOAD

Type	Hours	Percentage
Hours large group	13,0	10.40
Self study	86,0	68.80
Hours small group	26,0	20.80

Total learning time: 125 h

CONTENTS

1. Introduction

Description:
- Introduction to the course
- Introduction to the simulation framework

Full-or-part-time: 8h
Theory classes: 1h
Laboratory classes: 2h
Self study : 5h

2. Pulse Propagation in Optical Fibers

Description:
- Attenuation
- Temporal dispersion: modal dispersion, chromatic dispersion and polarization-mode dispersion (PMD)
- Non-linear effects: self-phase modulation (SPM), cross-phase modulation (XPM) and four wave mixing (FWM)

Full-or-part-time: 39h
Theory classes: 4h
Laboratory classes: 8h
Self study : 27h

3. Optical Signal Transmission and Detection

Description:
- The IQ modulator
- The coherent receiver
- Complex modulation formats: QAM, Nyquist, OFDM, etc.
- Signal multiplexing: wavelength / polarization / space
- Noise modeling: amplified spontaneous emission (ASE) / thermal noise / phase noise
- System analysis and evaluation: bit error rate (BER) estimation

Full-or-part-time: 39h
Theory classes: 4h
Laboratory classes: 8h
Self study : 27h

3. Optical Amplification

Description:
- Semiconductor optical amplifiers (SOA)
- Erbium-doped fiber amplifiers (EDFA)
- Raman amplifiers

Full-or-part-time: 10h
Theory classes: 1h
Laboratory classes: 2h
Self study : 7h

5. Digital Signal Processing for Optical Communications

Description:
- Chromatic dispersion compensation
- Frequency and phase recovery
- Polarization tracking
- Clock recovery

Full-or-part-time: 29h
Theory classes: 3h
Laboratory classes: 6h
Self study : 20h

ACTIVITIES

Coding

Description:
Design and evaluation of an advanced fiber-optic communications system using Matlab.

Full-or-part-time: 48h
Self study: 48h

Technical Reports

Description:
Scientific paper-like reports on the code implementation and results obtained.
- 2 Intermediate reports
- 1 Final report

Full-or-part-time: 30h
Self study: 30h

Oral Presentation

Description:
Slide-based oral presentation of the final report.

Full-or-part-time: 9h 30m
Self study: 8h
Theory classes: 1h 30m

Final Exam

Description:
Final examination of the course.

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

GRADING SYSTEM

Final exam: 40%
Scientific reports: 45%
Oral presentation: 15%

BIBLIOGRAPHY

Basic:
- Kaminov, I.P.; Li, T.; Willner, A.E. (eds.). Optical fiber telecommunications: V: vol.B: systems and networks. San Diego: Academic Press, 2008. ISBN 978-0123741721 (VOL. B).
- Agrawal, G.P. Nonlinear fiber optics. 6th ed. London: Elsevier : Academic Press, 2019. ISBN 9780128170427.
- Binh, Le Nguyen. Optical fiber communication systems with MATLAB and Simulink models [on line]. Boca Raton, Fla: CRC, 2015 [Consultation: 16/06/2021]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1680665. ISBN 9781482217520.
- Jeruchim, M.C.; Balaban, P.; Shanmugan, K.S. Simulation of Communication Systems [on line]. 2nd ed. New York: Kluwer Academic Publishers/Plenum, 2002 [Consultation: 16/06/2021]. Available on: https://link.springer.com/book/10.1007%2Fb117713. ISBN 0306462672.

Complementary:
- Ramaswami, R.; Sivarajan, K.N.; Sasaki, G.H. Optical networks: a practical perspective [on line]. 3rd ed. San Francisco: Morgan Kaufmann, 2010 [Consultation: 22/09/2020]. Available on: http://www.sciencedirect.com/science/book/9780123740922. ISBN 9780123740922.
- Saleh, B.E.A.; Teich, M.C. Fundamentals of photonics. 3rd ed. Hoboken: John Wiley & Sons, 2019. ISBN 9781119506874.