Course guides
300433 - SFO-OT - Optical Fiber Sensors: Technologies and Applications

Last modified: 27/05/2019

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

Degree: **Academic year:** 2019 **ECTS Credits:** 3.0
Languages: Catalan, Spanish

LECTURER

Coordinating lecturer: Definit a la infoweb de l'assignatura.

Others: Definit a la infoweb de l'assignatura.

PRIOR SKILLS

It is recommended that you have passed Optical Communications.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE 13. CE 13 TELECOM. Capacidad para comprender los mecanismos de propagación y transmisión de ondas electromagnéticas y acústicas, y sus correspondientes dispositivos emisores y receptores. (CIN/352/2009, BOE 20.2.2009.)

Transversal:
04 COE N3. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
05 TEQ N2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

TEACHING METHODOLOGY

The subject will be based on lectures on: 1) Introduction to Optical Fiber Sensors; 2) Distributed Optical Fiber Sensors and 3) Industrial Applications of Optical Fiber Sensors.

LEARNING OBJECTIVES OF THE SUBJECT

The basic objective of this course is focused on the study and analysis of the technologies and applications of optical sensors implemented by optical fibers. In the first place, the technological evolution of the key components and sub-systems for the implementation of sensors with fiber optic technology will be described. Next, the interrogation systems will be described and analyzed so that the optical fiber can behave like a distributed sensor (with thousands of sensors) able to measure temperature, elongations, vibrations, acoustic waves, etc. The unique properties of optical fibers together with the excellent performance of distributed sensors allow the implementation of powerful monitoring systems (tens of kilometers) with excellent performance. Due to its simplicity and features, sensors based on Fiber Bragg Grating technology will also be analyzed. Finally, the main industrial applications of said fiber optic sensors will be detailed.

STUDY LOAD

Type	Hours	Percentage
Self study	42,0	56.00
Hours large group	33,0	44.00

Total learning time: 75 h

CONTENTS

Introduction to Optical Fiber Sensors (OFS)

Description:
An introduction to the optical fibers-based sensors will be given, highlighting moreover, the main systems invloved, such as:
1) Optical Sensors: Types and Applications
2) Distributed Optical Fiber Sensors (DOFS): Technologies and Applications
3) Fiber Bragg Grating Sensors: Types and Applications
4) Key Optical Technologies for OFS
I.5.- Optical Time Domain Reflectometry (OTDR): Key Subsystem for OFS.

Full-or-part-time: 9h
Theory classes: 3h
Self study : 6h

Optical Time Domain Reflectometry (OTDR)

Description:
OTDR: Basic Principles

1) Types of OTDR
2) OTDR-Interrogator System Design for DOFS:
- Block Diagram Design
- Performances:
- SNR.
- Signal processing.
- Sensing fiber range.
- Resolutions.
- Measurement time

Full-or-part-time: 15h
Theory classes: 6h
Self study : 9h

Distributed Optical Fiber Sensors (DOFS)

Description:
III.1.- Raman-based Distributed Temperature Sensors (DTS):
III.1.1.-Raman Scattering: applications to measure temperature
III.1.2.-Theory of Raman-DTS system
III.1.3.-OTDR-Raman DTS Interrogator System:
o Types
o Performances: Measurement time, Sensing fiber range, Spatial and Temperature resolutions
III.2.-Brillouin-based Distributed Temperature and Strain Sensors (Brillouin-DTS and Brillouin-DSS):
III.2.1.-Brillouin Scattering: application to measure temperature and strain.
III.2.2.-Theory of Brillouin-DTS and Brillouin-DSS systems
III.2.3.-OTDR-Brillouin DTS or DSS Interrogator System:
o Types
o Performances: Measurement time, Sensing fiber range, Spatial and Measurement resolutions.
III.3.- Rayleigh-based Distributed Acoustic and Vibration Sensors (Ryleigh-DAS and Rayleigh-DVS)
III.3.1.-Rayleigh Scattering: applications to measure acoustic waves and vibrations
III.3.2.-Theory of Rayleigh-DAS and Rayleigh-DVS system
III.3.3.-OTDR-Rayleigh DAS or DVS Interrogator System:
o Types
o Performances: Measurement time, Sensing fiber range, Spatial and Measurement resolutions

Full-or-part-time: 28h
Theory classes: 13h
Self study : 15h

Fiber Bragg Grating (FBG) sensors

Description:
- Bragg Gratings in Optical Fibers: Fundamentals, types and applications
- Types of interrogation system.
- High Capacity WDM Distributed Sensing System
- Performance measurements: temperature, strain, etc.
- FBGs in multicore fiber for curvature sensing

Full-or-part-time: 13h
Theory classes: 7h
Self study : 6h

Applications of Optical Fiber Sensorsh

Description:
Applications of Distributed Optical Fiber Sensors, with special emphasis to smart cities applications.

Full-or-part-time: 10h
Theory classes: 4h
Self study : 6h

GRADING SYSTEM

The evaluation will be based on a final exam and on the preparation of a report technical report about the contents of the subject.

EXAMINATION RULES.

Defined in the course webpage at the EETAC website.

BIBLIOGRAPHY

Basic:
- Hartog, Arthur H. An Introduction to distributed optical fibre sensors [on line]. Boca Raton, FL: CRC Press, Taylor & Francis Group, 2017 [Consultation: 08/03/2019]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=4865550. ISBN 9781351645300.
- Rao, Yun-Jiang; Ran, Zeng-Ling; Gong, Yuan. Fiber-optic fabry-perot sensors : an introduction [on line]. Boca Raton: CRC Press, 2017 [Consultation: 08/03/2019]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=4850461. ISBN 9781498736947.