

EE513 Fiber Optic Sensors (3-0)

Wednesday: 9:45-12:30

Text Books: Rayleigh-based optical reflectometry

M. Wuilpart

An Introduction to Distributed optical fibre sensors

Arthur H. Hartog

CRC Press

Fiber Optic Sensors

Ericc Udd, William B. Spillman

Wiley

Fiber Optic Test and Measurement

Chapter 4: Wavelength Meters

Chapter 5: High Resolution Optical Frequency Analysis

Chapter 10: Optical Reflectometry for Component Characterization

Chapter 11: OTDRs and Backscatter Measurements

D. Derickson

HP Company

Prentice Hall

Scientific articles:

An Overview of the Recent Advances in FBG-Assisted Phase-Sensitive OTDR Technique and its Applications

K Yüksel, J Jason, EB Kocal, MLA Sainz, M Wuilpart

2020 22nd International Conference on Transparent Optical Networks (ICTON), 1-7

A comprehensive study of optical fiber acoustic sensing

Y. Wang et al.,

IEEE Access, 2017

10.1109/ACCESS.2019.2924736

Distributed Fiber-optic sensors for vibration detection,

Xin Liu,

Sensors 2016, 16, 1164

Distributed fiber sensor and machine learning data analytics for pipeline protection against extrinsic intrusions and intrinsic corrosions

Z.Peng et al., Optics Express, Vol.28,No.19, 2020.

Recent progress in the performance enhancement of phase-sensitive OTDR vibration sensing systems,

Romain Zinsou,

Sensors, 2019, 19, 1709

Towards a Uniform Metrological Assessment of Grating-Based Optical Fiber Sensors: From Refractometers to Biosensors

Francesco Chiavaioli et al.,
Biosensors **2017**, 7, 23; doi:10.3390/bios7020023

A Simple All-Optical Water Level Monitoring System Based on Wavelength Division Multiplexing with an Arrayed Waveguide Grating

Sensors **2019**, 19, 3095; doi:10.3390/s19143095

Discrimination of chemicals via refractive index by EF-FLRD

Alim Yolalmaz
Applied Physics B (2019) 125:156 <https://doi.org/10.1007/s00340-019-7261-5>

Grading

Project (Presentation and report).....30 %
Simulation Homework.....30 %
Final Exam (written and oral).....40 %

Course coordinator: Dr. Kıvılcım Yüksel Aldoğan

Contents

- 1) Introduction & course outline
- 2) Review of optical fiber technology
 - a. Optical fibers
 - b. Light sources
 - c. Optical detectors
 - d. Modulators
 - e. Passive devices
- 3) Intensity-based sensors
 - a. Water level measurement
 - b. Position detection
 - c. Point vibration sensor
- 4) Fiber Grating Sensors
 - a. Fabrication
 - b. Modelling of fiber grating sensors
 - c. Multi-parameter sensitivity problem
 - d. Applications
 - e. Future perspectives
- 5) Distributed FOS
 - a. Rayleigh backscatter
 - b. Principles of OTDR
 - c. Brillouin and Raman scattering
 - d. Polarisation concepts (review) and P-OTDR
 - e. Photon counting OTDR, Phase-OTDR
 - f. Optical Frequency Domain Reflectometry
 - g. Distributed vibration sensing (DAS) and its applications.

- 6) Interferometric FOS
 - a. Optical modulators for fiber optic sensors
 - b. Mach-Zehnder and Michelson interferometers
 - c. Fading issue
 - d. Sagnac interferometer and passive ring resonator
 - e. Fiber-optic gyroscope
 - f. Faraday effect and current sensor

- 7) Multiplexing of FOS

- 8) Fiber Optic Biosensors
 - a. Sensor classes
 - b. Transducer mechanisms
 - c. Vital sign monitoring
 - d. Biochemical sensing
 - e. Plastic fiber optic endoscope
 - f. Fiber optic smart bed

Course plan:

Week-1	INTRO & Course Outline
Week-2	REVIEW OF FIBER OPTIC TECHNOLOGY
Week-3	FIBER GRATING SENSORS I (Fabrication, types, multi-parameter sensitivity)
Week-4	DISTRIBUTED FOS-I (Rayleigh scattering and classical OTDR)
Week-5	DISTRIBUTED FOS-II (Raman-, Brillouin-based reflectometry)
Week-6	DISTRIBUTED FOS-III (Polarisation in optical fiber, P-OTDR, application in current sensors)- <i>by Şamil ŞİRİN</i>
Week-7	DISTRIBUTED FOS-IV (Phase sensitive OTDR, FBG-assisted Phase-OTDR, crosstalk effects)- <i>by Ertunga B. KOÇAL</i>
Week-8	DISTRIBUTED FOS-V (Optical frequency-domain reflectometry and its applications, challenges and perspectives of OFDR)

Week-9	FIBER GRATING SENSORS II (Applications)
Week-10	INTERFEROMETRIC FOS-I (principles)
Week-11	ROUND-TABLE DISCUSSION, SIMULATION HOMEWORK
Week-12	INTERFEROMETRIC FOS-II (state-of-the-art sensors)
Week-13	ROUND-TABLE DISCUSSION, FINAL PRESENTATION CORRECTIONS
Week-14	FINAL PRESENTATION (open to public)
Week-15	FINAL EXAM (ORAL & WRITTEN)