

## **EE513 Fiber Optic Sensors (3-0)**

**Friday: 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 Cmpany

Prentice Hall

### **Scientific articles:**

#### **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

#### **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

## **Optical Chemical Sensors: Design and Applications**

Aleksandra Lobnik

2002, DOI: 10.5772/31534 · Source: InTech

## **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**

|                                   |      |
|-----------------------------------|------|
| Midterm.....                      | 25 % |
| Student simulation homeworks..... | 25 % |
| Student research homeworks.....   | 25 % |
| Presentation and report.....      | 25 % |

**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
- 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,
  - f. Phase-OTDR
  - g. Optical Frequency Domain Reflectometry
  - h. Distributed vibration sensing (DAV) 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
  
- 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  |
| Week-2  | REVIEW OF FIBER OPTIC TECHNOLOGY                                     |
| Week-3  | FIBER GRATING SENSORS  |
| Week-4  | DISTRIBUTED FOS-I  |
| Week-5  | Special Session on Sensor Technologies (ASYU 2019, Yaşar University) |
| Week-6  | LAB-SESSION (PASSIVE DEVICES, OTDR)                                  |
| Week-7  | DISTRIBUTED FOS-II   |
| Week-8  | DISTRIBUTED FOS-III  |
| Week-9  | INTERFEROMETRIC FOS-I  |
| Week-10 | INTERFEROMETRIC FOS-II   |
| Week-11 | HOMEWORK EVALUATION & DISCUSSION                                     |
| Week-12 | LAB-SESSION (INTERFEROMETRIC SENSOR)                                 |
| Week-13 | MIDTERM  |
| Week-14 | FIBER OPTIC BIOSENSORS   |
| Week-15 | ROUND-TABLE DISCUSSION,<br>FINAL PRESENTATION CORRECTIONS            |
| Week-16 | FINAL PRESENTATION (open to public)                                  |