

Ph.D. in Information and Communication Technologies – ICT

Ph.D. Course:

“Nonlinear Optics and Applications”

Edition 2019 (30 hours, 6 credits)

Class Objectives

The course reviews the fundamental principles of nonlinear optics, along with its applications to key technologies in the field of telecommunications and biomedicine. Starting from basic principles, we introduce the main concepts and techniques involved in the study of linear and nonlinear optical wave propagation. We overview laser sources, and their applications to the study of quadratic and cubic nonlinear optical processes in bulk media and in waveguide geometries. We conclude by discussing the main applications of nonlinear optics to optical communications, spectroscopy and medical imaging.

Class Schedule

The course will be held **from April 3rd to June 3rd, 2019** in the **seminar room** at the second floor of the DIET department, Via Eudossiana 18, 00184 Rome, Italy, with the following schedule:

Wednesday	April 3rd	14:00-16:00	Room DIET 09.
Friday	April 5th	10:00-13:00	Reading room at the second floor of DIET Dpt.
Tuesday	April 9th	10:00-13:00	Reading room at the second floor of DIET Dpt.
Friday	April 12th	10:00-12:00	Reading room at the second floor of DIET Dpt.
Monday	April 15th	10:00-13:00	Reading room at the second floor of DIET Dpt.
Tuesday	April 30th	10:00-13:00	Reading room at the second floor of DIET Dpt.
Thursday	May 2nd	10:00-12:00	Reading room at the second floor of DIET Dpt.
Monday	May 13th	10:00-12:00	Reading room at the second floor of DIET Dpt.
Friday	May 24rd	14:00-17:00	Reading room at the second floor of DIET Dpt.
Tuesday	May 28th	10:00-13:00	Reading room at the second floor of DIET Dpt.
Friday	May 31st	14:00-16:00	Reading room at the second floor of DIET Dpt.
Monday	June 3rd	10:00-13:00	Reading room at the second floor of DIET Dpt.

Syllabus

1. Fundamentals of nonlinear optics

- 1.1 Introduction to nonlinear optics
- 1.2 Waves and fields
- 1.2 Maxwell equations
- 1.4 Linear absorption and refractive index
- 1.5 Lasers
- 1.6 Polarization effects
- 1.7 Group velocity
- 1.8 General nonlinear optics

2. Quadratic and cubic nonlinear processes

- 2.1 Quadratic nonlinearity: second harmonic generation
- 2.2 Difference frequency generation and optical parametric amplification
- 2.3 Cubic nonlinearity: induced gratings and nonlinear refractive index
- 2.4 Self-phase modulation and supercontinuum generation
- 2.5 Optical solitons
- 2.6 Two photon absorption and Raman scattering.

3. Applications

- 3.1 Optical communications
- 3.2 Nonlinear spectroscopy
- 3.3 Nonlinear microscopy

Final Examination

Discussion of a scientific paper related to the course.

Learning and teaching support materials

Class slides.

About the Lecturer

Stefan Wabnitz obtained the Laurea Degree in Electronics Engineering from Sapienza University of Rome in 1982, the MS in Electrical Engineering from Caltech in 1983, and the PhD in Applied Electromagnetism from the Italian Ministry of Education in 1988. He was with the Ugo Bordoni Foundation between 1985 and 1996. In 1996, he became full professor in Physics at the University of Burgundy in Dijon, France. Between 1999 and 2003 he was with Alcatel Research and Innovation Labs in France and with Xtera Communications in Texas. Since 2007 until 2018 he was full professor at the University of Brescia, Italy. Since November 2018 he is full professor in telecom at the Department of Information, Electronics and Telecom Engineering of Sapienza University of Rome. His research activities involve nonlinear propagation effects in optical communications and information processing devices. He is the author and co-author of over 700 international refereed papers, conference presentations, and book chapters. He is the Editor-in-Chief of Elsevier's Optical Fiber Technology, a Fellow member of the Optical Society of America, and senior member of IEEE-Photonics Society.

Google Scholar: <https://scholar.google.it/citations?user=KE7tIU8AAAAJ&hl=it>