UNIVERSITÀ DI PAVIA

Anno Accademico 2021/2022

NONLINEAR OPTICS

Enrollment year	2021/2022
Academic year	2021/2022
Regulations	DM270
Academic discipline	FIS/03 (MATERIAL PHYSICS)
Department	DEPARTMENT OF ELECTRICAL,COMPUTER AND BIOMEDICAL ENGINEERING
Course	ELECTRONIC ENGINEERING
Curriculum	Photonics
Year of study	1°
Period	2nd semester (07/03/2022 - 17/06/2022)
ECTS	6
Lesson hours	45 lesson hours
Language	English
Activity type	ORAL TEST
Teacher	TARTARA LUCA (titolare) - 6 ECTS
Prerequisites	Basics of electromagnetic theory and photonics
Learning outcomes	The subject of the course is the description of nonlinear interaction of laser with matter aimed to the understanding of the working principles of integrated optical devices performing wavelength conversion, modulation, and logical functions. The applications of nonlinear optics to information technology, environmental monitoring, and biomedical sciences are also treated.
Course contents	Second-order nonlinear phenomena Nonlinear propagation in the paraxial approximation. Phase-matching conditions. Second harmonic generation. Parametric amplification and oscillation. Wavelength conversion of ultrashort pulses: spectral acceptance, temporal walk-off. Materials for nonlinear optics. Phase-matching techniques.

	Third-order nonlinear phenomena Third harmonic generation. Optical Kerr effect, self focusing, self phase modulation. Four-wave mixing: wavelength conversion, optical phase conjugation. Ultrashort pulses Relation between pulsewidth and spectral bandwidth. Nonlinear propagation of ultrashort pulses in optical fibers. Temporal solitons. Measurement of pulsewidth via correlations. Coherence and correlation Classical definition of temporal and spatial coherence. Measurement techniques. Definition by Glauber: higher-order correlation functions. Heterodyne technique. Comparison between lasers and conventional light sources. Spontaneous and stimulated light scattering Static and dynamic Rayleigh scattering. Raman and Brillouin scattering. Scattering by Brownian and flowing particles. Doppler velocimetry. LIDAR techniques for environmental monitoring. Laser trapping. Biomedical applications. Stimulated Raman and Brillouin scattering. Raman amplifiers and oscillators. CARS technique.
Teaching methods	Lectures (hours/year in lecture theatre): 45 Practical class (hours/year in lecture theatre): 0 Practicals / Workshops (hours/year in lecture theatre): 0
Reccomended or required readings	G. New. Introduction to Nonlinear Optics. Cambridge University Press, 2011. R.W. Boyd. Nonlinear Optics. Academic Press, London, 2003. A. Yariv. Quantum Electronics. Wiley, New York, 1989.
Assessment methods	Oral examination about the topics of the course aimed at assessing the degree of comprehension of the student.
Further information	Oral examination about the topics of the course aimed at assessing the degree of comprehension of the student.
Sustainable development goals - Agenda 2030	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. $lbl_legenda_sviluppo_sostenibile