Dottorato di Ricerca in Fisica

UNIVERSITÀ DI PAVIA
Dipartimento di Fisica
"Alessandro Volta"

Title:	*Fourier and Physical Optics*
Lecturers:	Prof. Daniel E. Adams (Colorado School of Mines, USA), Prof. Giulia Fulvia Mancini (UNIPV, IT)
Duration:	20 hours of frontal lectures
Period:	February - March 2026

Content:

Overview:
This course covers the principles of scalar diffraction theory applied to optical systems. The primary analytic and computational tools of the subject rely on Fourier analysis. Consequently, the introductory material is a review of Fourier transforms and related theorems. After reviewing Fourier analysis, we examine approximate solutions to Maxwell's equations related to wave mechanics. The resulting diffraction formalism provides a layer of abstraction that links Fourier and linear systems analysis to the physics of optics. The same principles are applied to analyze the spatiotemporal evolution of ultrashort pulses.

Program and contents:
1) Fourier transforms
2) Fourier theorems
3) Scalar diffraction theory: Kirchhoff formulation
4) Beam propagation methods
5) Analysis of complex optical systems
6) Frequency analysis of optical imaging systems
7) Scattering theory approach
8) Fourier analysis applied to ultrafast optics

Expected results:
The student shall be capable of solving a computational project applied to a concrete problem and application of Fourier Optics

Teaching Methods:
Frontal, interactive lectures with homework

Learning verification methods:
Exam: Computational project and its discussion.

Materials

Introduction to Fourier Optics Joseph W. Goodman, Fourth Edition | 2017 ISBN: 9781319119164

Computational Fourier Optics: A MATLAB Tutorial
David G. Voelz | 2011
ISBN: 9780819482044

Supplemental Reading
Diffraction Physics John M. Cowley, Third Edition | 1995
ISBN: 0444822186