COURSE DATA

Data Subject	
Code	43307
Name	Advanced optical instrumentation
Cycle	Master's degree
ECTS Credits	6.0
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
2150 - M.D. in Advanced Physics	Faculty of Physics	1	First term

Subject-matter

Degree	Subject-matter	Character
2150 - M.D. in Advanced Physics	6 - Elements of advanced optics	Optional

Coordination

Name	Department
GARCIA MONREAL, FRANCISCO JAVIER	280 - Optics and Optometry and Vision Sciences
MARTINEZ CORRAL, MANUEL	280 - Optics and Optometry and Vision Sciences
SAAVEDRA TORTOSA, GENARO	280 - Optics and Optometry and Vision Sciences

SUMMARY

Statistical optics: representation and modeling of stochastic signals. Estimators. Optical coherence. Difraccional analysis of the formation of 2D and 3D images. Physical limits of the resolution: transfer function and impulse response. Specialized optical inspection techniques (high resolution microscopy, digital holography, ...).

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

OUTCOMES

LEARNING OUTCOMES

At the end of the teaching-learning process the student will have learned:

1. Understanding and use of the optical properties of linear and nonlinear material resources to support the design and manufacture of photonic devices.
2. Understanding the physical basis of the interaction of light with matter, in particular the laser emission, and the study of the fundamental characteristics of lasers of interest for photonics.
3. Understanding the elements of the theories of the signal and the information underlying the design of photonic transmission, processing and storage.
4. Learning the modern techniques of optical instrumentation in both inspection systems as imaging devices.
5. Understanding recent developments in devices and emerging technologies relevant to optical instrumentation in different fields of science and technology.

DESCRIPTION OF CONTENTS

1. INTRODUCTION TO THE GEOMETRICAL MODEL OF INSTRUMENTAL OPTICS

The Geometrical Optics Model. Paraxial Optics. Matrix Optics. Basic optical instruments.

2. DIFFRACTION THEORY OF IMAGING

Diffraction model of light propagation. Fourier Optics: impulse response and transfer function. Imaging under coherent and incoherent illumination.

3. BASIC TECHNIQUES IN OPTICAL MICROSCOPY

Imaging in Optical Microscopy. Illumination systems. Resolution limits. Optical contrast techniques: dark field, phase contrast, differential interference,...

4. THREE-DIMENSIONAL OPTICAL MICROSCOPY

3D imaging in Optical Microscopy. Optical sectioning. 3D Optical Microscopy techniques: confocal microscopy, structured illumination microscopy,...

5. PRINCIPLES OF OPTICAL COHERENCE THEORY

Analytical signal and spectrum. Spatial and temporal coherence. Mutual coherence and its propagation.

6. SCALAR DIFFRACTION: NUMERICAL ALGORITHMS

Discrete Fourier transform vs Fourier transform. Scalar diffraction: exact, paraxial and Fresnel approximations.

7. HOLOGRAPHY

Wavefront recording. Principles of holography. Digital holography. Image formation by holography.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	36,00	100
Laboratory practices	4,00	100
Other activities	4,00	100
Seminars	3,00	100
Development of group work	8,00	0
Development of individual work	8,00	0
Preparing lectures	45,00	0
Preparation of practical classes and problem	42,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

MD1 - Standar theory lecture
MD3 - Problems solving
MD4 - Problems
MD5 - Seminars.
MD6 - Visit to external scientific facilities and companies
MD7 - Addressed debate or discussion.

Although the course is primarily taught in Spanish, some subjects may be taught in English.

EVALUATION

SE1 - Written exam on the theory and practical lectures: based on the results of learning and the specific objectives of each subject. (55%)

SE3 - Continuous evaluation of students in the classes of theory and practice: participatory assistance and exercises in the classroom. (5%)

SE4 - Continuous assessment of students in laboratory classes: participatory attending, handling, instrumentation and equipment, work organization, understanding and use of practice outlines, calculations performing, analysis of results, teamwork, etc. (5%)

SE5 - Evaluation of non-presential activities related to theory and practical lectures: reports (and problems) submitted. (35%)

REFERENCES

Basic

- Born, M. and Wolf, E. (1985). Principles of Optics. Pergamon.
- Goodman, J. (1968). Introduction to Fourier Optics. McGraw-Hill.
- Mandel, L. and Wolf, E. (1995). Optical Coherence and Quantum Optics. Cambridge University
- Kreis, K. (2005). Handbook of Optical Interferometry. Wiley.
- Gu, M. (2000). Advanced Optical Imaging Theory. Springer.