VNIVERSITAT DE VALÈNCIA

Course Guide

43307 Advanced optical instrumentation

COURSE DATA

DATA SUBJECT

Code: 43307
Name: Advanced optical instrumentation
Cycle: Master's Degree
ECTS Credits: 6
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
2150 - Master's degree in Advanced Physics	Facultat de Física	1	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
2150 - Master's degree in Advanced Physics	Elements of advanced optics	ELECTIVES

COORDINATION

MARTINEZ CORRAL MANUEL

SAAVEDRA TORTOSA GENARO

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

COMPETENCES / LEARNING OUTCOMES

2150 - Master's degree in Advanced Physics

Students should demonstrate self-directed learning skills for continued academic growth.

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

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	36,00
Seminar	3,00
Other activities	4,00
Laboratory	4,00
Total hours	**47,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	16,00
Independent study and work	0,00
Preparation of lessons	45,00
Preparation for assessment activities	0,00
Resolution of case studies	42,00
Total hours	**103,00**

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%)

This evaluation system will be used for both the first and second call.

REFERENCES

- 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.