COURSE DATA

DATA SUBJECT

Code: 34316
Name: Computer-aided optical design
Cycle: Undergraduate Studies
ECTS Credits: 4.5
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
1207 - Degree in Optics and Optometry	Facultat de Física	4	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1207 - Degree in Optics and Optometry	Biomedical optics	ELECTIVES

COORDINATION

GARCIA MONREAL FRANCISCO JAVIER

SUMMARY

Calculation and design of optical systems. Principles of matrix optics, aberration optimization and image quality criteria. Knowledge and use of optical design programs. Simulation of the visual optical system.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

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

OTHER REQUIREMENTS

Previous knowledge of Physics II (Geometric Optics), Optical and Optometric Instruments and Physical Optics is recommended.

COMPETENCES / LEARNING OUTCOMES

-

Being able to gather and interpret relevant data to make judgments.

Knowing how to apply the knowledge acquired to professional activity, knowing how to solve problems and develop and defend arguments.

To acquire basic skills to handle optical design computer programs.

To know the fundamentals of the design and optimization of optical systems.

DESCRIPTION OF CONTENTS

1. Introduction to Optical Design

The basic principles used in optical design are described, such as material properties, surface shapes, successive application of refraction and reflection in optical systems. It is shown how complex systems can be solved by means of a chain of simple steps. The objectives to be achieved in the realization and optimization of an optical system are presented.

2. Matrix optics

Light ray vector and ABCD transfer matrix. Refraction matrix. Reflection matrix Translation matrix. Matrix between conjugate planes.

3. Optical design programs enviroment

Characteristics of optical design programs. Data area. Working area, graphic areas. Operations for the design of elements. Databases of materials and lenses. Interactive design.

4. Aberrations

Geometric or Seidel's aberrations: (Spherical aberration, coma, astigmatism, distortion, Petzval curvature). Optical materials and chromatic dispersion. Chromatic aberration

5. Image evaluation

Optical path difference. Focus shift. Tolerances in aberrations. Strehl ratio. Geometric distribution of energy in the image. Extension functions Modulation transfer functions (FTM/MTF). Calculation of the MTF of an optical system. Diffraction limited systems

6. Optical systems optimization

Generation of error function, parameters and variables, operands. Optimization of beams, aberration functions, materials and thicknesses.

7. Advanced designs

Mirror systems. Prisms. Non-spherical surfaces of revolution. Toric surfaces.

8. Human optical system simulation

Eye models. Simulation of ametropia. Retinal image quality evaluation

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	30,00
Computer classroom practice	15,00
Total hours	**45,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	7,50
Independent study and work	15,00
Preparation of lessons	45,00
Preparation for assessment activities	0,00
Resolution of case studies	0,00
Total hours	**67,50**

TEACHING METHODOLOGY

The course consists of two types of classes with differentiated methodology

a) Theoretical and practical classes

b) Laboratory sessions in the computer classroom.

In the first ones, the basic contents of the course and practical examples will be taught. For this purpose,

blackboard and video-projector presentations will be used. In the explanations of the optical design program, a computer with video projector will be used dynamically. If the classroom has computers for the students, they can implement the above examples.

In the second, students will directly use a computer with a graphic design program to implement the examples explained in the theoretical classes and work on new designs required for the practical lessons. The skill in the use of the software and the originality of the designs will be encouraged here.

EVALUATION

In the first call, the evaluation will be done by means of the presentation by the students of exercises proposed by the professor, which can be done during the theoretical and practical classes, or as autonomous work of the student.

In the second call, there will be a practical exam with computer where the student will have to solve several designs and problems related to them.

REFERENCES

- b1:Software de diseño óptico OSLO: http://www.lambdares.com/oslo
- b2:D. Malacara, Handbook of Optical design. Taylor and Francis. 2004
- b3:W.J.Smith. Modern Optical Engineering. McGraw-Hill
- c1:W.T. Welford. Aberrations of Optical Systems. Adam Hilger. 1991

- c2:OSA. Handbook of Optics