COURSE DATA

Data Subject	
Code	34316
Name	Computer-aided optical design
Cycle	Grade
ECTS Credits	4.5
Academic year	2023 - 2024

Study (s)

Degree	Center	Acad. year	Period
1207 - Degree in Optics and Optometry	Faculty of Physics	4	First term

Subject-matter

Degree	Subject-matter	Character
1207 - Degree in Optics and Optometry	16 - Optional subjects	Optional
1207 - Degree in Optics and Optometry	19 - Biomedical optics	Optional

Coordination

Name	Department
GARCIA MONREAL, FRANCISCO JAVIER	280 - Optics and Optometry and Vision Sciences
SILVA VAZQUEZ, FERNANDO	280 - Optics and Optometry and Vision Sciences

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.

OUTCOMES

1207 - Degree in Optics and Optometry

- Knowing how to apply the knowledge acquired to professional activity, knowing how to solve problems and develop and defend arguments.
- Being able to gather and interpret relevant data to make judgments.
- To know the fundamentals of the design and optimization of optical systems.
- To acquire basic skills to handle optical design computer programs.

LEARNING OUTCOMES

Students are expected to understand the fundamentals of non-paraxial optics and its application to real optical systems. For this purpose, they will learn to use software for the design of real optical systems.

They will also learn to use elements that indicate the quality of the optical system and its optimization.

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

ACTIVITY	Hours	% To be attended
Computer classroom practice	15,00	100
Tutorials	15,00	100
Theory classes	15,00	100
Development of group work	7,50	0
Study and independent work	15,00	0
Preparing lectures	30,00	0
Preparation of practical classes and problem	15,00	0
TOTAL	**112,50**	

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

Basic

- Software de diseño óptico OSLO: http://www.lambdares.com/oslo
- D. Malacara, Handbook of Optical design. Taylor and Francis. 2004
- W.J.Smith. Modern Optical Engineering. McGraw-Hill

Additional

- W.T. Welford. Aberrations of Optical Systems. Adam Hilger. 1991
- OSA. Handbook of Optics