Bachelor in Physics
(Academic Year 2025-26)

Optics				**Code**	800500	**Year**	2nd	**Sem.**	2nd
Module	General Core	**Topic**	Classical Physics			**Character**	Obligatory		

	Total	**Theory**	**Exercises**
ECTS Credits	7.5	4.5	3
Semester hours	69	39	30

Learning Objectives (according to the Degree's Verification Document)

1. To get knowledge of the polarized light representations.
2. To understand light propagation in homogenous medium.
3. To understand the coherence concept.
4. To get knowledge of interference and diffraction processes and fundaments in interferometers and diffraction grating.

Brief description of contents

Polarization and electromagnetic waves in vacuum. Light propagation in homogeneous medium. Coherence. Interference. Interferometers. Scalar Diffraction Theory. Resolution power. Diffraction granting.

Prerequisites

Algebra. Calculus. Physics Fundamental.

Coordinator	Gemma Piquero Sanz		**Dept.**	OP
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Theory/Problems – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	19	Mo,Tu, Fr	10:30 – 12:00 10:00 – 12:00	Luis Lorenzo Sánchez Soto	Full term	69	T/E	OP

T: Theory, E: Exercises

Office hours				
Grupo	**Professor**	**Schedule**	**e-mail**	**Location**
B	Luis Lorenzo Sánchez Soto	X:16:00-18:00	r.m-h@fis.ucm.es	01.306.0

Syllabus

1. **Electromagnetic waves in vacuum.** General solution to Maxwell's equations in vacuum. Spherical and plane harmonic waves. Poynting's vector, irradiance, and time averaging. Complex representation and polarization states of light. Polarizers and Malus law. Jones representation.

2. **Classical microscopic theory for light-matter interaction.** The Lorentz oscillator model. Light scattering and polarization.

3. **Light propagation through material media.** Optically dilute and dense media. Solutions of the macroscopic Maxwell equations. Constitutive relations. Optically transparent and absorbing materials.

4. **Propagation through homogeneous and isotropic media.** Microscopic model for the refractive index in dielectrics and conductors. Complex refractive index and complex wave vector. Absorption and attenuation vector. Dispersion relations.

5. **Reflection and transmission of light at media interfaces.** Boundary conditions. Fresnel equations. Reflectance and transmittance. Polarization (Brewster) angle. Total internal reflection. Evanescent waves.

6. **Interference and introduction to the coherence theory of light.** Superposition of light pulses, coherence length, and coherence time. Young, Michelson, and Fabry-Pérot interferometers. Fringe visibility and resolving power.

7. **Scalar diffraction theory of light.** The Huygens-Fresnel principle. Fresnel and Fraunhofer approximations. Diffraction patterns generated by different apertures. Babinet's principle. Resolving power of optical instruments.Diffraction gratings and spectral resolving power. Introduction to spatial frequency filtering.

Bibliography

Reference book:

A. Ghatak, Optics, McGraw-Hill Higher Education (2010), International Edition.

Equivalent reference books:

G. R. Fowles, Introduction to Modern Optics, Dover (1989).

R. Guenther, Modern Optics, John Wiley & Sons (1990).

Supplementary:

I. G. Main, Vibration and Waves in Physics, Cambridge University Press (1993), 3rd Edition.

M. Born and E. Wolf. Principles of Optics, Cambridge University Press (1999), 7th (expanded) Edition.

Online Resources

- Teaching material (notes, presentations, videorecordings, web links with pedagogical interest, etc.) used in theory lectures and practice sessions will be made available through the Virtual Campus.

- Online tutoring/mentoring, either individual or group sessions, with the format of video conferences (through Microsoft Teams, Google Meet, Zoom) upon prior appointment, or by email.

Methodology
The course includes the following training activities: – Theory lectures, where the contents of the course will be presented and discussed, illustrated by means of examples and applications. – Practice sessions, aimed at problem solving and where teaching experiences may also be delivered, as well as other activities, e.g., focused discussions, oral presentations, etc. – Tutorials, aimed at discussing and solving technical questions either at a personal level or in small groups. In the classroom, the teacher may make use of the blackboard, multimedia resources (e.g., projected presentations), computer simulations, etc. The Virtual Campus will be used to promote and support both the contact and the exchange of information with students.

Evaluation Criteria		
Exams	**Weight:**	55 %
There will be a written final exam.		
Other Activities	**Weight:**	45 %
Along the term, there might be one or two handwritten midterm control tests within teaching hours, as well as other supplementary activities, such as delivery of selected problems or questions suggested by the teacher, programmed tasks to be submitted through the Virtual Campus, etc.		
Final Mark		

The final mark will comprise the following contributions:

* A written final examination covering all the contents delivered in the course, with two independent parts: either a quiz or a test with brief questions, and a problem solving exam.

* A summative assessment coming up from two contributions:
  - Written midterm examinations, each consisting of either a quiz or a test with brief questions.
  - Other activities performed either in the classroom or outside.

The final mark, on a 0-10 scale, will be:

$$F = 0.55\ F2 + \text{Max}(0.45\ F1,\ 0.35\ ME + 0.1\ OA)$$

F = Final mark.
F1 = Final written examination: part concerning the quiz or brief questions.
F2 = Final written examination: part concerning the problem solving.
ME = Average arising from the written midterm examinations.
OA = Other activities.
Any mark in the equation is on a 0-10 scale.
Should the score obtained from the summative assessment be ME > 5, the part of the final mark concerning the quiz or brief questions F1 can be skipped. Yet the student might carry it out in order to get a higher score.
The marks ME and OA considered in the May-June ordinary final exam will also be kept, would it be the case, for the July extraordinary final exam.