

**COURSE DATA****DATA SUBJECT****Code:** 34296**Name:** Mechanisms and models of vision**Cycle:** Undergraduate Studies**ECTS Credits:** 6**Academic year:** 2025-26**STUDY (S)**

| Degree | Center | Acad. year | Period |
|---------------------------------------|--------------------|------------|----------------|
| 1207 - Degree in Optics and Optometry | Facultat de Física | 3 | Second quarter |

SUBJECT-MATTER

| Degree | Subject-matter | Character |
|---------------------------------------|----------------------|------------|
| 1207 - Degree in Optics and Optometry | Visual perception II | COMPULSORY |

COORDINATION

CAPILLA PEREA PASCUAL

MALO LOPEZ JESUS

SUMMARY

The course *Mechanisms and Models of Vision*, which is part of the *Visual Perception* subject area, focuses on the study of neural mechanisms involved in visual perception, as well as the simplest models that quantitatively describe the perception of color, shape and motion. The models covered will be limited to linear models that rely on low-level mechanisms (that is, up to the striate cortex).

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 Psychophysics of Vision is required, as well as an elementary knowledge



of the anatomy and physiology of the visual system.

COMPETENCES / LEARNING OUTCOMES

1207 - Degree in Optics and Optometry

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

Being able to transmit information, ideas, problems and solutions to both a specialized and non-specialized audience.

Development of learning skills necessary to undertake further studies with a high degree of autonomy.

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

To have and to understand the fundamentals of Optometry for its correct clinical and healthcare application.

To know and to apply Fourier theory to vision models.

To know how to correlate psychophysical experiments with the physiology of the visual system.

To know the basic models of color, shape and movement vision.

To know the basic models of vision.

To know the spatial and temporal aspects of vision.

To know the spatial and temporal chromatic aspects of vision.

DESCRIPTION OF CONTENTS

- Neural foundations of vision
introduction: structure and function of the visual system. the retina and visual pathways. the striate cortex.
- Color vision
introduction: cone excitations vs tristimulus values. (linear) models based on trichromatic theory. chromatic and achromatic mechanisms: (linear) models with opponent transformation.



- Spatial vision
introduction: image spectrum. the visual system as a filter: the single-channel model. contrast sensitivity in color space. the visual system as a discrete set of filters: multichannel models.
- Spatiotemporal properties of the visual system and motion perception
introduction: uses of motion information. contrast sensitivity in the spatiotemporal domain: the spatiotemporal CSF. mechanisms and models of motion perception.
- Practical exercises (seminars and lab)
 - (1) computer-generated images
 - (2) instruments for color vision: color calibration
 - (3) tristimulus colorimetry/appearance in LMS and ATD
 - (4) instruments for spatial vision: calibration of extent/spatial frequency
 - (5) LGN neuron responses to LMS images
 - (6) responses of achromatic and chromatic CSFs to LMS images
 - (7) V1 neuron responses to LMS images
 - (8) instruments for motion vision: calibration of time and temporal frequency
 - (9) spatiotemporal CSF response
 - (10) pattern visibility

WORKLOAD

PRESENCIAL ACTIVITIES

| Activity | Hours |
|--------------------|--------------|
| Tutorials | 15,00 |
| Theory | 30,00 |
| Laboratory | 15,00 |
| Total hours | 60,00 |

NON PRESENCIAL ACTIVITIES

| Activity | Hours |
|---------------------------------------|--------------|
| Attendance at other activities | 0,00 |
| Individual or group project | 40,00 |
| Independent study and work | 45,00 |
| Preparation of lessons | 0,00 |
| Preparation for assessment activities | 5,00 |
| Resolution of case studies | 0,00 |
| Total hours | 90,00 |

TEACHING METHODOLOGY



The course will consist of:

-Conventional classes in which the teacher will explain the theoretical content of the program topics, using the blackboard and audiovisual media. The files with the Power Point presentations that will be used in the classes, as well as the videos that are necessary to illustrate the different visual phenomena, will be provided to the student in advance.

-Practical classes in which the experimental and computational techniques necessary to solve the exercises will be shown, and the necessary illustrative examples will be solved by the teacher. This task will be done in seminar classes. Next, the students will carry out the exercises that are proposed using the appropriate tools. This task will be done in laboratory classes. Therefore, the seminar classes and the laboratory constitute a single thematic unit in this course (UT 5).

EVALUATION

The assessment will consist of two parts:

A.- A theory exam made up of 5 theoretical¿practical questions.

B.- Submission of the exercises proposed during the practical sessions (seminars and laboratory).

Attendance at practical sessions is mandatory.

Each part will be worth 5 points. In order to combine both scores, a minimum of 4 out of 10 must be obtained in each.

In the second examination session, any of the two marks that have passed the cut¿off grade will be retained. If necessary, the student will only need to retake the theory exam (if failed) or submit the practical exercises (if not submitted or if they did not reach the minimum mark).

REFERENCES

Referencias básicas:

- Capilla, P. *Percepción visual: psicofísica, mecanismos y modelos*. Editorial Médica Panamericana, 2019. ISBN 978-84-9835-959-6.
- Capilla, P., Pujol, J., Artigas, J.M. *Fundamentos de colorimetría*. Servei de Publicacions de la Universitat de València, 2002. ISBN 978-84-370-5411-6.
- Hubel, D.H. *Ojo, cerebro y visión*. Servicio de Publicaciones de la Universidad de Murcia,



1999. ISBN 978-84-7684-898-2.

Referencias complementarias:

- Wandell, B. *Foundations of Vision*. Sinauer Associates, 1995. ISBN 978-0878938534.
- Spillmann, L., Werner, J.S. *Visual Perception: The Neurophysiological Foundations*. Academic Press, 1990. ISBN 978-0126576815.
- Rodieck, R.W. *The First Steps in Seeing*. Sinauer Associates, 1998. ISBN 978-0878934390.
- Gegenfurtner, K.R., Sharpe, L.T. *Color Vision: From Genes to Perception*. Cambridge University Press, 1999. ISBN 978-0521590736.