370526 - PSICOFISIC - Psychophysics and Neurophysiology of Vision

Coordinating unit: 370 - FOOT - Terrassa School of Optics and Optometry
Teaching unit: 731 - OO - Department of Optics and Optometry
Academic year: 2018
Degree: BACHELOR’S DEGREE IN OPTICS AND OPTOMETRY (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 7,5
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Jaume Pujol Ramo (http://futur.upc.edu/JaumePujolRamo)
Aurora Torrents Gomez (http://futur.upc.edu/AuroraTorrentsGomez)
Others: César Urtubia Vicario (http://futur.upc.edu/CesarurtubiaVicario)

Degree competences to which the subject contributes

Specific:
1. Anatomy, histology, physiology, biochemistry and neurophysiology of the visual system and the process of vision
2. Understanding the mechanism of imaging and information processing in the visual system.
3. Being able to take, treat, represent and interpret experimental data. "Use basic laboratory equipment and techniques"
4. Being able to perform literature searches.
5. Technical english applied to optics and optometry
6. Establish protocols, analyze results and elaborate the corresponding reports
7. Evaluate the process of formation of the optical image in the retina and the transmission and information processing in the brain
8. Value the nervous control of the visual system.
9. Value the effects (perceptual changes) caused by the glasses, optical aids and protection elements in the visual system.

General:
14. Extract the main points of a text or any source of information (oral or written)
15. Synthesize and organize information to convey it effectively orally and / or written
16. Display information orally and in writing of reasonably and coherent.
17. Develop methods to encourage teamwork participation of its members, critical thinking, mutual respect, the ability to negotiate to achieve common goals
18. Define the general objectives and to carry out a specific group
19. Apply the principles of emotional intelligence to develop a teamwork
20. Flexibility to integrate into dynamic environments, multidisciplinary and multicultural.
21. Capacity to assume different roles within the team, leadership, coordination with other members
Learning objectives of the subject

Understand the process of image formation and properties of optical systems.
Learn the basic models of vision.
Understand and handle basic laboratory equipment and techniques.
Understanding the basics and radiometric and photometric laws.
Knowing the parameters and eye models.
Understanding the factors that limit the quality of the retinal image.
Knowing the spatial and temporal aspects of vision.
Being able to perform psychophysical tests to determine levels of visual perception.
Knowing the properties and functions of the various elements of the visual system.
Understanding the mechanisms of ocular motor and sensory binocular vision.
Understand the functioning of the retina as a radiant energy receiver.
Learn the basic models of color vision, form and movement.
Being able to measure and interpret the data obtained in psychophysical assessment of visual perception.
### Study load

<table>
<thead>
<tr>
<th>Description</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total learning time</td>
<td>180h</td>
<td></td>
</tr>
<tr>
<td>Hours large group</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Hours medium group</td>
<td>63h</td>
<td>35.00%</td>
</tr>
<tr>
<td>Hours small group</td>
<td>12h</td>
<td>6.67%</td>
</tr>
<tr>
<td>Guided activities</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td>Self study</td>
<td>105h</td>
<td>58.33%</td>
</tr>
</tbody>
</table>
## Content

### Introduction to psychophysics and neurophysiology of vision

**Learning time:** 2h  
  Theory classes: 1h  
  Self study: 1h

**Description:**  
In this content we work:

- The visual process.  
- The retina and the visual pathways.  
- The electromagnetic spectrum.  
- Eye light transmission  
- Introduction to psychophysics and neurophysiology of vision.

### Psychophysical methods

**Learning time:** 12h  
  Theory classes: 3h  
  Laboratory classes: 2h  
  Self study: 7h

**Description:**  
In this content you work:

- Threshold measures.  
- Psychophysical methods for the detection of the threshold.  
- Weber's Law.  
- Magnitude and sensation.

**Related activities:**  
Activity 1 is carried out.

### The visual stimulus

**Learning time:** 18h  
  Theory classes: 6h  
  Laboratory classes: 2h  
  Self study: 10h

**Description:**  
In this content we work:

- Basic concepts and units.  
- Retinal illumination.  
- Light sources.  
- Characteristics of light sources.  
- Filters.

**Related activities:**  
Activity 2 is carried out.
### Dual nature of the retina

**Description:**
In this content we work:

- Range of operation of visual system.
- Scotopic and photopic vision.
- Cones and rods
- Photopic and scotopic visual spectral sensitivity.
- Adapt to darkness.
- Adaptation to light.
- Spatial resolution and spatial summation.
- Stiles-Crawford Effect.

**Related activities:**
Activity 3 is carried out.

**Learning time:**
- Theory classes: 6h
- Laboratory classes: 2h
- Self study: 10h

### Color vision

**Description:**
In this content we work:

- Trichromatic theory.
- Theory of opponents colors.
- Perceptual attributes of color.
- Discrimination of the wavelength.
- Bezold-Brücke Effect.
- Color constancy.
- The Munsell color appearance system.
- The CIE color specification system.
- Additive and subtractive mixtures.
- Clinical applications.

**Related activities:**
Activity 4 is carried out.

**Learning time:**
- Theory classes: 5h
- Laboratory classes: 2h
- Self study: 10h
<table>
<thead>
<tr>
<th><strong>Anomalies of color vision</strong></th>
<th><strong>Learning time:</strong> 12h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study : 8h</td>
</tr>
</tbody>
</table>

**Description:**
In this content we work:

- Classification.
- Properties of the deficiencies of the vision of the color.
- Perception of color in dichromats and abnormal trichromats.
- Acromatopsias and chromatopsias.
- Tests of color vision.

<table>
<thead>
<tr>
<th><strong>Spatial vision</strong></th>
<th><strong>Learning time:</strong> 17h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 6h</td>
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<tr>
<td></td>
<td>Laboratory classes: 2h</td>
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<tr>
<td></td>
<td>Self study : 9h</td>
</tr>
</tbody>
</table>

**Description:**
In this content we work:

- Modulation transfer function.
- Contrast sensitivity function (CSF).
- Factors affecting CSF.
- Clinical measure of CSF.
- Clinical applications of MTF and CSF.

**Related activities:**
Activity 5 is carried out
### Temporal vision

**Description:**
- Perception of brief and intermittent stimuli.
- Temporal contrast sensitivity function (TCSF).
- Factors affecting TCSF.
- Clinical applications of TCSF.
- Perception of movement.

**Learning time:** 10h
- Theory classes: 4h
- Self study: 6h

### Basic neurophysiology

**Description:**
- The neuron.
- Glial cells.
- Membrane potential and action potential.
- Neuronal excitability.
- Propagation of action potential.
- The synapse.
- Neural circuits.

**Learning time:** 10h
- Theory classes: 4h
- Self study: 6h
### Visual processing in the retina

**Description:**
In this content we work:
- Structure of the retina.
- Main neurons.
- Receptive fields of ganglion cells.
- Photoreceptors.
- Horizontal cells.
- Bipolar cells.
- Amacrine cells.
- Ganglion cells.
- First and second synapses.
- Clinical Considerations.

**Learning time:** 15h
- Theory classes: 5h
- Self study: 10h

### Parallel processing

**Description:**
In this content we work:
- The central nervous system.
- Main visual pathway
- Parvocellular and magnocellular systems.
- Secondary visual pathway
- Clinical applications.

**Learning time:** 14h
- Theory classes: 4h
- Self study: 10h
### Visual processing in the brain

**Description:**
In this content we work:
- Cerebral cortex and brain areas.
- Striated cortex.
- Circumcised cortex.
- Psychophysics and neurophysiology.
- Clinical Considerations.

**Related activities:**
Activity 6 is carried out

<table>
<thead>
<tr>
<th>Learning time</th>
<th>Theory classes: 6h</th>
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<tbody>
<tr>
<td></td>
<td>Laboratory classes: 2h</td>
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<tr>
<td></td>
<td>Self study : 12h</td>
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### Gross electrical potentials

**Description:**
In this content we work:
- Electrooculogram.
- Electroretinogram.
- Visual evoked potentials.

<table>
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<tr>
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<th>Theory classes: 8h</th>
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<td>Self study : 6h</td>
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</table>
## Planning of activities

| ACTIVITY 1: LABORATORIO. MEDIDA DE LA AV MEDIANTE DIFERENTES MÉTODOS PSICOFÍSICOS | Hours: 2h  
Laboratory classes: 2h |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Activity to be done in the laboratory, in groups, with a duration of 2 hours. In the laboratory, the experimental part will be carried out, and as directed autonomous learning, the student is expected to read the notes and answer the corresponding questionnaire to identify the objectives to be achieved after the experiment. Prior to the experimentation, the teachers make an assessment through questions to the students that allows to identify the degree of autonomous learning achieved. The practice is performed in the Laboratory of Physiological Optics, building TR8, plant -2.</td>
</tr>
<tr>
<td><strong>Support materials:</strong></td>
<td>All material for the realization of the experiment in the laboratory and corresponding software, detailed notes of the activity with the questionnaire and notes of the subject available in ATENEA.</td>
</tr>
<tr>
<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong></td>
<td>Registration by the professor of the verification of autonomous learning of the student and of the work in the laboratory. The student submits the questionnaire with the results of the experiment at the end of the session. This is returned corrected and with the corresponding feedback from the professor.</td>
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</tbody>
</table>
| **Specific objectives:** | At the end of the activity the student should be able to:  
? Understand the different psychophysical methods used.  
? Perform AV measurements using different psychophysical methods used.  
? Understand the concept of psychometric function. |

| ACTIVITY 2: LABORATORIO. LEY DE STEVENS | Hours: 2h  
Laboratory classes: 2h |
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<tr>
<td><strong>Support materials:</strong></td>
<td>All material to perform the experiment in the laboratory and corresponding software (tutorial), detailed notes of the activity with the questionnaire and notes of the subject available in ATENEA.</td>
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<td><strong>Descriptions of the assignments due and their relation to the assessment:</strong></td>
<td>Registration by the professor of the verification of autonomous learning of the student and of the work in the laboratory. The student submits the questionnaire with the results of the experiment at the end of the session. This is returned corrected and with the corresponding feedback from the professor.</td>
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| **Specific objectives:** | At the end of the activity the student should be able to:  
? Understand the concepts of magnitude and sensation and their relationship.  
? Verify Stevens’ law. |
ACTIVITY 3: LABORATORIO. FUNCIÓN DE SENSIBILIDAD AL CONTRASTE  

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 2h</th>
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<td>Activity to be done in the laboratory, in groups, with a duration of 2 hours. In the laboratory, the experimental part will be carried out, and as directed autonomous learning, the student is expected to read the notes and answer the corresponding questionnaire to identify the objectives to be achieved after the experiment. Prior to the experimentation, the teachers make an assessment through questions to the students that allows to identify the degree of autonomous learning achieved. The activity is performed in the Laboratory of Physiological Optics, building TR8, plant -2.</td>
<td>Laboratory classes: 2h</td>
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<tbody>
<tr>
<td>At the end of the activity the student should be able to:</td>
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<tr>
<td>? Understand the concept of contrast sensitivity function.</td>
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<tr>
<td>? Measure the contrast sensitivity function using different tests (sheets and specific PC program).</td>
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ACTIVITY 4: PHOTOMETRIC MAGNITUDES AND LIGHT SOURCES  

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<thead>
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<td>Laboratory classes: 2h</td>
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<th>Specific objectives:</th>
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</thead>
<tbody>
<tr>
<td>At the end of the activity the student should be able to:</td>
<td></td>
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<tr>
<td>Familiarize yourself with the radiometric and photometric concepts and magnitudes</td>
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<tr>
<td>Understand the main features of light sources</td>
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</tbody>
</table>

ACTIVITY 5: VISUAL PHENOMENA  

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<thead>
<tr>
<th>Description:</th>
<th>Hours: 2h</th>
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</thead>
<tbody>
<tr>
<td>Activity to be done in the laboratory, in groups, with a duration of 2 hours. In the laboratory, the experimental part will be carried out, and as directed autonomous learning, the student is expected to read the notes and answer the corresponding questionnaire to identify the objectives to be achieved after the experiment. Prior to the experimentation, the professor makes an assessment through questions to the students that allows to identify the degree of autonomous learning achieved.</td>
<td>Laboratory classes: 2h</td>
</tr>
</tbody>
</table>
ACTIVITY 6: LUMINANCE THRESHOLDS

Description:
Activity to be done in the laboratory, in groups, with a duration of 2 hours. In the laboratory, the experimental part will be carried out, and as directed autonomous learning, the student is expected to read the notes and answer the corresponding questionnaire to identify the objectives to be achieved after the experiment. Prior to the experimentation, the professor makes an assessment through questions to the students that allows to identify the degree of autonomous learning achieved.

Support materials:
All the material for the realization of the experiment in the laboratory and corresponding software, detailed notes of the activity with the questionnaire and notes of the subject are available in ATENEA.

Specific objectives:
At the end of the activity the student should be able to:
Justify some visual phenomena from a neurophysiological point of view

ACTIVITY 7: FIRST TEST

Description:
Individual test of two hours of duration. The test consists of a theoretical part where questions are formulated concerning theoretical concepts of the contents given in class and in a practical part, where several problems have to be solved.
### Support materials:
Theoretical notes and problems available through the ATENEA virtual campus and recommended bibliography. Formulation of the questions and problems, calculator and set of formulas.

### Descriptions of the assignments due and their relation to the assessment:
Resolution of the test. It represents 40% of the final mark of the subject.

### Specific objectives:
At the end of the test the student should be able to:
- Achieve the specific objectives of the contents 1-8

<table>
<thead>
<tr>
<th>ACTIVITY 8: SECOND TEST</th>
<th>Hours: 2h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
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</tbody>
</table>

**Description:**
Individual test of two hours of duration. The test consists of a theoretical part where questions are formulated concerning theoretical concepts of the contents given in class and in a practical part, where several problems have to be solved.

**Support materials:**
Theoretical notes and problems available through the ATENEA virtual campus and recommended bibliography. Formulation of the questions and problems, calculator and set of formulas.

**Specific objectives:**
At the end of the test the student should be able to:
- Achieve the specific objectives of the contents 9-13

<table>
<thead>
<tr>
<th>ACTIVITY 9: LABORATORY TEST</th>
<th>Hours: 1h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 1h</td>
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</tbody>
</table>

**Description:**
One-hour individual test. The test consists of solving issues seen in laboratory sessions

**Support materials:**
Theoretical notes and problems available through the ATENEA virtual campus and recommended bibliography. Formulation of the questions, calculator and set of formulas.

**Specific objectives:**
At the end of the test the student should be able to:
- Achieve the specific objectives of the ACTIVITIES 1-6

<table>
<thead>
<tr>
<th>ACTIVITY 10: ACTIVITIES OF CONTINUOUS ASSESSMENT AND RESOLUTION OF DOUBTS IN CLASS</th>
<th>Hours: 2h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
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</tbody>
</table>

**Specific objectives:**
At the end of the test the student should be able to:
- Achieve the specific objectives of the ACTIVITIES 1-6
Description:
Activities related to the contents of the subject will be proposed, which will include critical readings of scientific articles, problem solving in class, resolution of doubts in class, etc. Correction by PROFESSORS.

Support materials:
Theoretical notes, presentations, problems available through the ATENEA virtual campus and recommended bibliography.

Description of the assignments due and their relation to the assessment:
Presentation of the exercise of each of the groups with the corresponding common evaluation for each of the groups. With corresponding feedback from professors and general reflection in the classroom on the most common mistakes and associated learning objectives that should be reinforced. It represents 5% of the final mark of the subject.

Specific objectives:
Presentation of the brief summary of the article, the resolution of problems, etc. With corresponding feedback from professors and general reflection in the classroom on the most common mistakes and associated learning objectives that should be reinforced.

Qualification system
The final grade for the course comes from the partial marks obtained in the first test, the second test, and laboratory mark considering the following proportions:

Mark partial test: 40%
Mark final test: 35%
Laboratory mark: 20%
Mark continuous evaluation: 5%

The first test is an individual test of 2 hours. It contains theoretical questionnaires related to the concepts studied in class and a section of problems. The concepts evaluated in this test are the specific objectives of the contents 1, 2, 3, 4, 5, 6, 7 and 8.

The second test is an individual test of 2 hours. It contains theoretical questionnaires related to the concepts studied in class and a section of problems. The concepts evaluated in this test are the specific objectives of the contents 9, 10, 11, 12 and 13.

The score from the laboratory is obtained from the laboratory work (independent learning, performing experiments, the script activity questionnaire), and an exam.

The continuous evaluation score is obtained from resolution of problems in class and deliverables proposed along the course.

Regulations for carrying out activities
The attendance to the lab activities is mandatory.
Bibliography

Basic:


Complementary: