370504 - OPTIGEO - Geometrical and Instrumental Optics

Coordinating unit: 370 - FOOT - Terrassa School of Optics and Optometry
Teaching unit: 731 - 00 - Department of Optics and Optometry
Academic year: 2018
Degree: BACHELOR'S DEGREE IN OPTICS AND OPTOMETRY (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 9
Teaching languages: Catalan

Teaching staff
Coordinator: ELISABET PÉREZ CABRÉ (http://futur.upc.edu/ElisabetPerezCabre)
Others: JAUME ESCOFET SOTERAS (http://futur.upc.edu/JaumeEscofetSoteras)
MARIA SAGRARIO MILLÁN GARCÍA-VARELA (http://futur.upc.edu/MariaSagrarioMillanGarciaVarela)

Degree competences to which the subject contributes

Specific:
11. Technical english applied to optics and optometry
2. Understanding the physical basis of the behavior of fluids and the nature, generation and propagation of light, to understand their role in their own processes and applications of optics and optometry.
4. Determine the optical parameters of contact lenses in relation to the functionality of the visual system.
3. Determine, according to the visual limitations, optical aids for each case.
5. Making use of machinery, instruments and tools needed to make assembly, adjustments, repairs and quality control of finished product.
6. Identify the design and features of different specific aid for low vision.
7. Interpret refractive test results to determine the suitable optical prescription.
8. Being able to take, treat, represent and interpret experimental data. "Use basic laboratory equipment and techniques"
9. Value and report on the possibilities and limitations of specific visual aids for low vision.
10. Evaluate the process of formation of the optical image in the retina and the transmission and information processing in the brain
1. Understanding the mechanism of imaging and information processing in the visual system.

Generical:
12. Develop methods to encourage teamwork participation of its members, critical thinking, mutual respect, the ability to negotiate to achieve common goals
13. Display information orally and in writing of reasonably and coherent.
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. Assessing the acquisition of the course objectives.
The OVERALL OBJECTIVE of the course can be described as:
Study of the properties of the light. Set the geometric model to explain the propagation of light. Know the laws of geometrical optics. Describe the different elements of the optical system (diopters, mirrors, lenses and diaphragms). Apply the geometric model to explain the light paths and the formation of images in paraxial approximation. Knowing the optical aberrations. Correcting the most easier aberrations. Know the photometric and radiometric quantities. Learn simple optical instruments (lenses, eyepieces, camera lenses and projection systems) and optical instruments compounds (glasses and microscopes). Describe from the point of the paraxial approximation how the images are formed and the photometry in these instruments.

At the end of Geometrical and instrumental Optics course, students must achieve the following OBJECTIVES (taken from the BOE):
- Understand the imaging process and properties of optical systems.
- Understand and manage material and basic laboratory techniques.
- Learn about the propagation of light in isotropic media, the light-matter interaction, light interference, diffraction phenomena, the properties of surface monolayers and multilayers and the principles of lasers and their applications.
- Know the principles, description and characteristics of the fundamental optical instruments and instruments that are used in practice optometrists and ophthalmologists.
- Understand and calculate the geometric parameters, most important optical and physical that characterize the different types of lenses used in ophthalmic and optometric prescriptions knowledge related to the properties involved in the adaptation process.
- Training for calculating the geometrical parameters of the specific visual compensation systems: low vision, intraocular lenses, contact lenses and ophthalmic lenses.
- Know the aberrations of optical systems.
- Learn the basics and radiometric and photometric laws.
- Knowing the parameters and eye models.

And the SPECIFIC OBJECTIVES:
- To know a brief history of optics.
- Knowing the paradigms that make up the different models explaining the behavior of light.
- List and apply the laws that form the theoretical basis of geometrical optics.
- Interpret the meaning of the refractive index of a medium.
- Relate the wave surface and the rays of light.
- Describe and justify the phenomenon of dispersion.
- Explain the formation of the image of a point and an extended object.
- Describe the properties of a stigmatic.
- List the conditions for an optical system is considered perfect.
- Identify the combinations of prisms to reduce the spread or deviation.
- To know the total reflection prism.
- Explain the effects on investment and the displacement produced by the prisms in the images.
- Define increases lateral, angular and axial optical system.
- Determine the cardinal elements of an optical system.
- Apply the equations of correspondence in an optical system.
- Recognize and distinguish between different types of diaphragms.
- Indicate the limitations of the paraxial approximation.
- Name and identify, qualitatively, monochromatic aberrations or Seidel.
Identify, qualitatively, chromatic aberrations.
- Explain, qualitatively, the mechanisms for correcting optical aberrations.
- Know the main photometric magnitudes and relations between them.
- To interpret the curves of light intensity of a source of light.
- Know basic optical instruments. Describe the correct imaging and photometry of optical instruments.

**Study load**

<table>
<thead>
<tr>
<th>Total learning time: 221h</th>
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</thead>
<tbody>
<tr>
<td>Hours large group:</td>
</tr>
<tr>
<td>Hours medium group:</td>
</tr>
<tr>
<td>Hours small group:</td>
</tr>
<tr>
<td>Guided activities:</td>
</tr>
<tr>
<td>Self study:</td>
</tr>
</tbody>
</table>
# Content

## 1. Foundations of geometrical optics

**Description:**
1. Brief history of optics
2. Paradigm Optics
3. Geometrical optics. fundamental Laws
4. Light scattering
5. Fermat's principle.

**Related activities:**
Labs:
1. Getting beams of light and dark chamber
2. Determination of the limiting angle. total reflection
3. Dispersing prism. Measurement of the refractive index of prism

**Learning time:** 52h
- Practical classes: 16h
- Laboratory classes: 6h
- Self study: 30h

## 2. Image: optical representation of the object

**Description:**
1. Optical representation. Perfect imaging optical focusing systems
2. Astigmatic surfaces for two conjugate points
3. Paraxial optics: approximate astigmatism

**Related activities:**
Labs:
1. Plot of dioptric rays in different media and catoptrics

**Learning time:** 14h
- Practical classes: 2h
- Laboratory classes: 4h
- Self study: 8h
### 3. The optical surface and their combinations

**Description:**
1. Plane mirrors
2. Plane dioptria and plane-parallel plate.
3. Prisms
4. Diopters and spherical mirrors
5. The spherical surface paraxial optics
6. The thin lens

**Related activities:**
- Labs:
  1. Plane mirrors, kaleidoscopes
  2. Focometría in lenses
  3. Focometría mirrors

**Learning time:** 61h
- Practical classes: 19h
- Laboratory classes: 6h
- Self study: 36h

### 4. Paraxial characterization of image-forming systems.

**Description:**
1. Cardinal elements of an optical system
2. General equations of correspondence
3. Association focusing optics
4. The thick lens
5. Specific formulation for the eye

**Related activities:**
1. Determination of cardinal elements in optical systems

**Learning time:** 16h
- Practical classes: 4h
- Laboratory classes: 2h
- Self study: 10h
### 5. Real optical systems

<table>
<thead>
<tr>
<th>Description:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Diaphragms. Limiting aperture and field</td>
</tr>
<tr>
<td>2. Monochromatic Aberrations I: spherical, astigmatism and coma</td>
</tr>
<tr>
<td>3. Monochromatic Aberrations II: field curvature, distortion</td>
</tr>
<tr>
<td>4. Chromatic aberrations</td>
</tr>
<tr>
<td>5. Achromatic doublets</td>
</tr>
</tbody>
</table>

**Related activities:**
Labs:
1. Diaphragms
2. Aberrations

**Learning time:** 23h
- Practical classes: 6h
- Laboratory classes: 4h
- Self study: 13h

### 6. Photometry

<table>
<thead>
<tr>
<th>Description:</th>
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<tbody>
<tr>
<td>1. Visible spectrum and electromagnetic radiation</td>
</tr>
<tr>
<td>2. Radiometry</td>
</tr>
<tr>
<td>3. Photometry</td>
</tr>
</tbody>
</table>

**Related activities:**
Labs:
1. Photometry

**Learning time:** 14h
- Practical classes: 4h
- Laboratory classes: 2h
- Self study: 8h
### 7. Optics instruments

<table>
<thead>
<tr>
<th><strong>Description:</strong></th>
</tr>
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<tbody>
<tr>
<td>1. Photographic and projection tools</td>
</tr>
<tr>
<td>2. Vision devices I: eye, lens and eye</td>
</tr>
<tr>
<td>3. Vision devices II: binoculars, telescopes, microscopes</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Related activities:</strong></th>
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</thead>
<tbody>
<tr>
<td>Labs:</td>
</tr>
<tr>
<td>1. The photographic lens</td>
</tr>
<tr>
<td>2. The microscope</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Learning time:</strong></th>
</tr>
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<tbody>
<tr>
<td>36h</td>
</tr>
<tr>
<td>Practical classes: 11h</td>
</tr>
<tr>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td>Self study: 21h</td>
</tr>
</tbody>
</table>
## Planning of activities

### 1. LABORATORY. OBTAIN LIGHT BEAMS AND DARK CAMERA (CONTENT 1)

**Description:**
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

**Support materials:**
- All optical and mechanical equipment required for the experiment in the laboratory.
- Detailed script of the experiment.
- Spreadsheet to obtain the experimental results and graphics.

**Descriptions of the assignments due and their relation to the assessment:**
- Teacher registration by checking the reading and understanding the script.
- Record attendance at practice.
- The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script.
- The workload and the average score of all reports will represent 20% of the final grade for the subject.

**Specific objectives:**
- At the end of practice, the student must be able to:
  - To study the formation of images in a darkroom.
  - Check that the rays propagate in straight lines.
  - Exercising in the collection and use of light beams.

<table>
<thead>
<tr>
<th>Hours: 2h 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Self study: 0h 30m</td>
</tr>
</tbody>
</table>

### 2. LABORATORY. DETERMINATION OF ANGLE LIMIT. TOTAL REFLECTION (CONTENT 1)

**Description:**
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

**Support materials:**
- All optical and mechanical equipment required for the experiment in the laboratory.
- Detailed script of the experiment.
- Spreadsheet to obtain the experimental results and graphics.

**Descriptions of the assignments due and their relation to the assessment:**
- Teacher registration by checking the reading and understanding the script.
- Record attendance at practice.
- The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script.
- The workload and the average score of all reports will represent 20% of the final grade for the subject.

<table>
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<tr>
<th>Hours: 2h 30m</th>
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<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Self study: 0h 30m</td>
</tr>
</tbody>
</table>
Specific objectives:

At the end of practice, the student must be able to:
- Check the laws of refraction.
- Measure the critical angle on the phenomenon of total reflection.

### 3. LABORATORY. DISPERSER PRISMA.
MEASUREMENT OF THE REFRACTIVE INDEX
OF A PRISM (CONTENT 1)

**Description:**
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

**Support materials:**
- All optical and mechanical equipment required for the experiment in the laboratory.
- Detailed script of the experiment.
- Spreadsheet to obtain the experimental results and graphics.

**Descriptions of the assignments due and their relation to the assessment:**
- Teacher registration by checking the reading and understanding the script.
- Record attendance at practice.
- The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script.
- The workload and the average score of all reports will represent 20% of the final grade for the subject.

**Specific objectives:**
At the end of practice, the student must be able to:
- Observe the chromatic dispersion of white light passes through a prism.
- Measure the refractive index of a prism.

| Hours: 2h 30m |
| Laboratory classes: 2h |
| Self study: 0h 30m |

### 4. LABORATORY. TRACING GRAPHIC OF BEAMS IN CATOPTRICS AND DI OPTRICS MEDIA(CONTENT 2)

**Description:**
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

**Support materials:**
- All optical and mechanical equipment required for the experiment in the laboratory.
- Detailed script of the experiment.
- Spreadsheet to obtain the experimental results and graphics.
5. LABORATORY. PLANE MIRRORS.
KALEIDOSCOPE (CONTENT 3)

Description:
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

Support materials:
All optical and mechanical equipment required for the experiment in the laboratory. Detailed script of the experiment. Spreadsheet to obtain the experimental results and graphics.

Descriptions of the assignments due and their relation to the assessment:
Teacher registration by checking the reading and understanding the script. Record attendance at practice. The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script. The workload and the average score of all reports will represent 20% of the final grade for the subject.

Specific objectives:
At the end of practice, the student must be able to:
- Check the condition of astigmatism in reflective surfaces.
- Analyze the specular and diffuse reflection and check the laws of reflection.
- Observe and check the law of the optical lever.
- Observe and check the movement of the image by moving the mirror.
- Observe the images formed by the kaleidoscope of two mirrors and the periscope.
- Check the change in parity in multiple reflections.

Hours: 2h 30m
Laboratory classes: 2h
Self study: 0h 30m

6. LABORATORY. FOCOMETRY IN LENS
(CONTENT 3)

Hours: 2h 30m
Laboratory classes: 2h
Self study: 0h 30m
Description:
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

Support materials:
All optical and mechanical equipment required for the experiment in the laboratory.
Detailed script of the experiment.
Spreadsheet to obtain the experimental results and graphics.

Descriptions of the assignments due and their relation to the assessment:
Teacher registration by checking the reading and understanding the script.
Record attendance at practice.
The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script.
The workload and the average score of all reports will represent 20% of the final grade for the subject.

Specific objectives:
At the end of practice, the student must be able to:
- Calculate the value of the focal length by a thin converging lens and diverging.
- Compare different methods of measurement.

7. LABORATORY. FOCOMETRY IN SPHERICAL MIRRORS (CONTENT 3)

Description:
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

Support materials:
All optical and mechanical equipment required for the experiment in the laboratory.
Detailed script of the experiment.
Spreadsheet to obtain the experimental results and graphics.

Descriptions of the assignments due and their relation to the assessment:
Teacher registration by checking the reading and understanding the script.
Record attendance at practice.
The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script.
The workload and the average score of all reports will represent 20% of the final grade for the subject.

Specific objectives:
At the end of practice, the student must be able to:
- Calculate the value of the focal length in a convex and concave spherical mirror.
- Compare different methods of measurement.
### 8. LABORATORY. DETERMINATION CARDINAL ELEMENTS IN OPTICAL SYSTEMS. METHODS OF DAVANNE MARTIN AND CORNU (CONTENT 4)

**Hours:** 2h 30m  
Laboratory classes: 2h  
Self study: 0h 30m

**Description:**  
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

**Support materials:**  
All optical and mechanical equipment required for the experiment in the laboratory.  
Detailed script of the experiment.  
Spreadsheet to obtain the experimental results and graphics.

**Descriptions of the assignments due and their relation to the assessment:**  
Teacher registration by checking the reading and understanding the script.  
Record attendance at practice.  
The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script.  
The workload and the average score of all reports will represent 20% of the final grade for the subject.

**Specific objectives:**  
At the end of practice, the student must be able to:  
- Determine the cardinal elements of an optical system.  
- Measure the focal length of the system.

### 9. LABORATORY. DIAPHRAGMS (CONTENT 5)

**Hours:** 2h 30m  
Laboratory classes: 2h  
Self study: 0h 30m

**Description:**  
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

**Support materials:**  
All optical and mechanical equipment required for the experiment in the laboratory.  
Detailed script of the experiment.  
Spreadsheet to obtain the experimental results and graphics.

**Descriptions of the assignments due and their relation to the assessment:**  
Teacher registration by checking the reading and understanding the script.  
Record attendance at practice.  
The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script.  
The workload and the average score of all reports will represent 20% of the final grade for the subject.
### Specific objectives:
At the end of practice, the student must be able to:
- Observe the effect of limiting diaphragms as lighting systems and field.
- Relate the depth of field and focus to the diameter of the aperture diaphragm.
- Observe the vignetting of the image.
- To determine experimentally the position and size of diaphragm aperture and field, pupils and skylights.

### 10. LABORATORY. ABERRATION (CONTENT 5)

**Hours:** 2h 30m  
Laboratory classes: 2h  
Self study: 0h 30m

**Description:**
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

**Support materials:**
- All optical and mechanical equipment required for the experiment in the laboratory.
- Detailed script of the experiment.
- Spreadsheet to obtain the experimental results and graphics.

**Descriptions of the assignments due and their relation to the assessment:**
Teacher registration by checking the reading and understanding the script.  
Record attendance at practice.  
The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script.  
The workload and the average score of all reports will represent 20% of the final grade for the subject.

**Specific objectives:**
At the end of practice, the student must be able to:  
- Observe the effect of optical aberrations.

### 11. LABORATORY. PHOTOMETRY (CONTENT 6)

**Hours:** 2h 30m  
Laboratory classes: 2h  
Self study: 0h 30m

**Description:**
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

**Support materials:**
- All optical and mechanical equipment required for the experiment in the laboratory.  
- Detailed script of the experiment.  
- Spreadsheet to obtain the experimental results and graphics.
### Descriptions of the assignments due and their relation to the assessment:
- Teacher registration by checking the reading and understanding the script.
- Record attendance at practice.
- The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script.
- The workload and the average score of all reports will represent 20% of the final grade for the subject.

### Specific objectives:
- At the end of practice, the student must be able to:
  - Learn to use the meter and measure the light produced by a bulb.
  - Check the lighting depending on the inverse square of the distance.
  - Obtain and represent the intensity diagram of a light bulb from the light measured by the photometer.

### 12. LABORATORY. THE PHOTOGRAPHIC OBJECT (CONTENT 7) | Hours: 2h 30m

<table>
<thead>
<tr>
<th>Laboratory classes: 2h</th>
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</thead>
<tbody>
<tr>
<td>Self study: 0h 30m</td>
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</tbody>
</table>

**Description:**
All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice.

**Support materials:**
- All optical and mechanical equipment required for the experiment in the laboratory.
- Detailed script of the experiment.
- Spreadsheet to obtain the experimental results and graphics.

**Descriptions of the assignments due and their relation to the assessment:**
- Teacher registration by checking the reading and understanding the script.
- Record attendance at practice.
- The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script.
- The workload and the average score of all reports will represent 20% of the final grade for the subject.

**Specific objectives:**
- At the end of practice, the student must be able to:
  - Simulate an optical bench in a photographic lens and know how to explain the function of the different elements that constitute it.
  - Check the field variation on the focal image of the target.
  - Determine the parameters that influence the depth of field and focus.

### 13. LABORATORY. THE MICROSCOPE (CONTENT 7) | Hours: 2h 30m

<table>
<thead>
<tr>
<th>Laboratory classes: 2h</th>
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<tbody>
<tr>
<td>Self study: 0h 30m</td>
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</tbody>
</table>
14. TRACING GRAPHIC OF BEAMS  
(CONTENT 3)  

| Description: |  
| Realisation, by groups under the supervision of teachers, different exercises of tracing graphic beams of any optics system in paraxial approximation. |  
| Support materials: |  
| Notebook of tracing graphic of beams. |  

| Descriptions of the assignments due and their relation to the assessment: |  
| Record attendance at the activity. |  
| The student will respond to a series of exercises plot of lightning. |  
| The student will practice with the help of software plot of lightning. |  
| The student will work the same as the one conducted in a lab. |  

| Specific objectives: |  
| After the meeting, the student must be able to: |  
| - To form images using ray plot of any optics in paraxial approximation. |  

| Hours: |  
| 15h |  

| Self study: |  
| 15h |  

15. INDIVIDUAL TESTS CONTINUED ASSESSMENT IN ATENEÁ (UNITS 1-7)  

| Description: |  
| All practices have to be made in the laboratory in pairs and will last for 2 hours. Students must come to the session having made a previous reading of the script. The laboratory will have to carry out the experimental part. At the beginning of the session, the teacher will check, by oral questions, reading and understanding the script of practice. |  
| Support materials: |  
| All optical and mechanical equipment required for the experiment in the laboratory. |  
| Detailed script of the experiment. |  
| Spreadsheet to obtain the experimental results and graphics. |  

| Descriptions of the assignments due and their relation to the assessment: |  
| Teacher registration by checking the reading and understanding the script. |  
| Record attendance at practice. |  
| The student will prepare a report with the results of the experience made in the lab and answer any questions suggested in the script. |  
| The workload and the average score of all reports will represent 20% of the final grade for the subject. |  

| Specific objectives: |  
| At the end of practice, the student must be able to: |  
| - Simulate an optical bench in a compound microscope with Köhler illumination. |  
| - Find the intermediate image and final image provided by the microscope. |  
| - Identify the aperture diaphragm and field lighting system and image forming optical system. |  
| - Find the exit pupil of the instrument. |  

| Hours: |  
| 40h |  

| Self study: |  
| 40h |
18. INDIVIDUAL ASSESSMENT LABORATORY TEST (UNITS 1-7)

**Description:**
Individual test assessment in the laboratory. Two exams will be carried out during the term. Each pupil individually will reproduce part of a lab session. They will need to implement the experimental setup, obtain some measures and compute some results, as indicated in the exam guideline.

**Support materials:**
Exam guideline to be given the day of the assessment.

**Descriptions of the assignments due and their relation to the assessment:**
Lab report and measurements following the exam guideline. Represent 20% of the assessment mark.

**Specific objectives:**
After the test, the student must be able to:
- Assess their degree of attainment of learning objectives of the laboratory.

**Hours:** 14h
Self study: 14h

19. INDIVIDUAL PARTIAL TEST (UNITS 1-3)

**Description:**
Individual test in the classroom with theoretical concepts and solving problems related to the learning objectives of the contents of the course 1-3. Correction by the teacher.

**Support materials:**
Statements, provided that teachers form with proof, calculator, square and bevel for plotting.

**Descriptions of the assignments due and their relation to the assessment:**
Resolution of the test. Represents 30% of the final qualification of the subject.

**Specific objectives:**
The student must demonstrate that it has achieved the objectives set for each content of the course.

**Hours:** 22h
Self study: 20h
Practical classes: 2h
20. FINAL TEST (UNITS 1-7)

<table>
<thead>
<tr>
<th>Description:</th>
<th>Hours: 27h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual test in the classroom with theoretical concepts related to problem solving learning objectives of the course contents.</td>
<td>Practical classes: 2h</td>
</tr>
<tr>
<td>Support materials:</td>
<td>Self study: 25h</td>
</tr>
<tr>
<td>Statements, provided that teachers form with proof, calculator, square and bevel for plotting.</td>
<td></td>
</tr>
<tr>
<td>Descriptions of the assignments due and their relation to the assessment:</td>
<td></td>
</tr>
<tr>
<td>Resolution of the test. Represents 40% of the final qualification of the subject.</td>
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<tr>
<td>Specific objectives:</td>
<td></td>
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<tr>
<td>The student must demonstrate that it has achieved the objectives set for each content of the course.</td>
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</tbody>
</table>

Qualification system

Assessment will be through: self-tests, class participation exercises of problems (Q); work, lab reports and exams (L), a partial exam (P) and a final exam (F).

The final grade (N) is obtained using the formula:

\[ N = 0.10 \times Q + 0.20 \times L + 0.30 \times M + 0.40 \times F. \]

In case of total or partial copy in any assessments of the course shall apply to prevent the General Academic Regulations UPC: fraudulently perform any act of evaluation implies a minimum qualification of 0 in the act of evaluation and possibly more severe disciplinary proceedings.

Reassessment of Geometrical Optics and Optical Instruments will be taken according to general rules established in the “Normativa general de Graus i Màsters de la UPC” and to particular rules form the “Facultat d’ Òptica i Optometria de Terrassa”. It will be a single final exam covering all the subjects of the course.

A final grade of 5 will be awarded to students passing this exam, otherwise the previous grade will remain.

Regulations for carrying out activities

- If there is not done any laboratory activities or continuous assessment it will be not scored.
- Failure to attend two or more lab sessions will not pass the assessment for the works and reports of laboratory (L).
- Teachers will provide you a formulary in the partial and final tests.
Bibliography

Basic:


Complementary: