DIPLOMA IN EXPERIMENTAL PHYSICS
ADVANCED EXPERIMENTAL TECHNIQUES

Total contact hours 44

ECTS 6 (UC)

Taught by Francisco González (coordinator), Manuel P. Cagigal, José Ignacio Espeso, Luis Pesquera, Angel Valle

Learning goals related to Technical Competence:

In this course, students must carry out three experiments of an advanced level, this being its main objective. The experiments are of very diverse nature, and refer to different fields in physics. The student must acquire laboratory skills, use a variety of laboratory material, either of general or specific purpose and handle experimental data (fits, errors, graphs, etc).

The experiments are assigned from a pool of 6, described as follows:

EXPERIMENT N.1: Analysis of a light signal with a deterministic profile by means of photon counting.

In this experiment the student analyzes intensity fluctuating optical signals, deterministic in the time domain. A photon counting system is used, as well as the software required for the measurement or estimate, of the adequate statistical parameters. Attention is paid also to the processing and fitting steps from the raw experimental data to the parameters characterizing the signal.

EXPERIMENT N.2: Wavefront estimate with a Hartmann-Shack sensor

In this laboratory exercise the student learns the basic principles of wavefront measurement and wavefront reconstruction on a real set-up, and has to handle a group of instruments and software tools typical of an optics laboratory.

The specific objectives are: Alignment of an optics system, filtering of the light beam, image capture with a CCD camera and image processing with a software tool (Image Pro). The student learns how to obtain of the wavefront derivative and, from this, the Zernike polynomial series. Finally, the unknown wavefronts are represented by means of Mathcad.

EXPERIMENT N.3: Magnetic Materials Characterization (hysteresis cycle)

The hysteresis cycle of magnetic materials is measured by using the induction method with either AC or DC current. Some interesting aspects will be studied, like the effect of the mechanic strain on the hysteresis cycle, the importance of the sample geometry in the magnetization process, or the need of an adequate demagnetization process.

EXPERIMENT N.4: Characterization of Laser Diodes

The main objective is that the students understand how laser diodes operate and the main physical processes responsible for laser diode behaviour. Students will characterize laser diodes. They also will perform an experimental study of several applications of laser diodes.

Specific goals: Understand the basic concepts of laser diode operation; Gain experience with experimental equipment for laser diode characterization; Characterize laser diodes; Analyze laser diode behaviour under modulation of the injection current; Study bistability of laser diodes subject to optical injection.

Work will be carried out in the laboratories of the IFCA ("Instituto de Física de Cantabria", belonging to the national research council CSIC)
Methodological Competence:
- Comprehension of laboratory material, techniques, procedures and laboratory work in general.
- Use of laboratory and data processing software.
- Learning of the meaning of experimental results and its interpretation.

Social Competence:
- Cooperative work in group.
- Capacity for demanding help if required, expressing the questions in proper terms.
- Public presentation and defence of results.

Personal Skills:
- Learning and better comprehension of some natural phenomena.
- Ability to order and present results of a task developed in a more than sufficient, though limited, time, both in written and spoken means.

Contents

EXPERIMENT N.1: Analysis of a light signal with a deterministic profile by means of photon counting.
- Optics Laboratory; basement-

EXPERIMENT N.2: Wavefront estimate with a Hartmann-Shack sensor
- Optics Laboratory; third floor-

EXPERIMENT N.3: Magnetic Materials Characterization (hysteresis cycle)
- CITIMAC Laboratory-

EXPERIMENT N.4: Characterization of Laser Diodes
- IFCA Laboratories-

Teaching material
- Core Texts and Additional material:
  The experiment guiding texts and other reference sources will be provided for each of the experiments assigned to the student by the coordinator

Teaching methods
- The working groups (2 students, in principle) will be established by the coordinator of the course during the first week.
- Each group will carry out four experiments. The established time for one experiment...
ranges from 9 to 15 hours, distributed in an average of three afternoon/evening sessions.

· Each student must elaborate a complete report of one of the experiments (about 8 pages). For the rest of them, a more simple report will be presented. These reports must be given to the teaching person in charge of the experiment, and a copy of the first page given to the coordinator, before the next experiment is started.

· Each student will prepare and defend one of the experiments in an oral presentation (of about 20 minutes).

· The exact time-table, assignation of experiments to groups and presentations calendar will be proposed by the coordinator to the students accordingly with the segments established for the course and the disponibility of labs and students.

· Contact hours (57)
  Starting session = 1h
  Experiments (4) x 3 sessions x 4h each (approx.) = 48h
  Tutorizing requirements (4 experiments, 1h each) = 4h
  Seminar sessions (2 x 2h) = 4h

· Personal work (73)
  Experiments preparation and guide’s reading: 2 x 4h = 8h
  Reports elaboration = 50h
  Seminar preparation = 15h

· Total workload = 150h

Assessment

· The experiment selected for the long report weights 34% of the overall mark. The others 22% each.

· In the assessment of each experiment’s results the following issues will be taken into consideration: Personal work (15%), report (85%). (In the case of an experiment with report and oral presentation, the weights will be 55% and 30% for that 85%)

· If an student prefers to be assessed by a single examination, this exam will consist of two experiments proposed by the coordinator of the course, each weighting 50% of the mark. The student will have the guide of the experiments a week before, and should carry out all the tasks proposed by the teacher and explain clearly the procedure followed for it. In a week time the student should produce an 8 pages (approximately) report of the experiments, weighting the labwork and the report 50% of the mark each.

Workload

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<thead>
<tr>
<th>Contact hours:</th>
<th>-Described in teaching methods-</th>
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<tbody>
<tr>
<td>Preparation and follow up of lectures:</td>
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</tr>
<tr>
<td>Student’s work at laboratory:</td>
<td></td>
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<td>Presentations:</td>
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International aspects

- Experiments developed in research labs and coordinated by lecturers with international research experience.
- Coordinators of the experiments will be encouraged to include the participation of teachers of International origin.
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<tr>
<th>Cross-cultural reference</th>
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<tbody>
<tr>
<td>Course language</td>
<td>English</td>
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<tr>
<td>Integration of business partners</td>
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<td>Particularities</td>
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