CIMET Photonics and Optics Fundamentals 2010-11

Course name: Photonics and Optics Fundamentals **Course code:** CIMET POF

Course level: Master **ECTS Credits:** 5.00

Course instructors: Javier Romero (University of Granada), Youcef Ouerdane & Nathalie Destouches-Castagna (University Jean Monnet)

Education period (Dates): 1st semester
Language of instruction: English

Expected prior-knowledge: undergraduate course of Physics (waves and electromagnetism), undergraduate course of mathematics (algebra and calculus).

Aim and learning outcomes:

This course develops an understanding of the fundamentals of Optics and Photonics focused on light models (geometrical, electromagnetic, quantum), propagation of light (rays), classical interaction of light with matter (reflection, refraction, absorption, scattering, chromatic dispersion), classical interaction of light with light (interferences, diffraction), paraxial theory of imaging systems and quality of imaging systems (aberrations, resolving power).

On completion of this course the students will be able to:

- Know basic optical phenomena involved in the generation of color of objects from a physical point of view.
- Understand the fundamentals and the basic tools which explain these phenomena.
- Use the basic techniques involved in the geometrical theory of imaging systems.
- Have a clear idea of the influence of aberrations and diffraction in the quality of images.

Course outline:

1. **Introduction**: Basic definitions. Overview of light models: geometrical, electromagnetic and quantum. Basic concepts: refraction index, ray and optical length. Light propagation: rays in homogenous and heterogeneous media. Reflection and refraction laws.

2. **Fundamentals of Electromagnetic Optics**: Plane and spherical waves. Electromagnetic waves characteristics. Electromagnetic spectrum. Intensity. Coherence.

3. **Polarization**: Unpolarized, partially polarized and polarized lights. Birefringence. Dichroism and polarizers. Retarders. Induced birefringence. Polarization and reflection. Liquid crystals.

4. **Classical interaction of light with matter:** Absorption. Chromatic dispersion. Scattering.

5. **Interferences and diffraction**: Interferences. Double-slit Young's experiment. Multiple-wave interferences. Difraction phenomena, Huygens-Fresnel Principle. Fraunhofer diffraction through different apertures. Diffraction gratings.

6. **Imaging systems**: Optical systems. Paraxial Optics. Spherical refractive surface. Mirrors. Thick lenses. Thin lenses. Prisms. Basic optical instruments: the human eye and the photographic camera.

7. **Quality of imaging systems**: Wave and ray aberrations. Third-order aberrations. Chromatic aberrations. Difraction-limited systems: resolving power.

8. **Quantum Optics**: Photons. Matter quantization. Basic processes between energy levels: absorption, spontaneous emission and stimulated emission.

Lab experiments:

1. Polarization.
2. Difraction
3. Interferences.
4. Imaging systems.

Teaching methods: Lectures and lab classes, and homework exercises.

Form(s) of Assessment: Written exam (Theoretical questions + exercises); Lab work (reports) + home work.

External/internal examiner: --
One internal and one external examiner

Examination:
Two exams along the semester, both 2 hours long. We consider them as two parts of the same exam, and then each of them has a value of 50% of the final mark. The first part will take place at the end of October and will cover the course program up to interferences (included). The second part will take place before Christmas and will cover the rest of the program.

Each exam will consist in 4 or 5 questions: 2 or 3 theoretical questions and 2 or 3 exercises containing different parts with increasing level of difficulty.

The exams will be done by the students without the help of notes or books.

Second opportunity for the students who fail an exam will take place in November for the first part and at the beginning of the second semester for the second part.

Grading
From 0 to 10 in all the exams and evaluation of reports of the lab work.

Literature and study materials:

Reference book:
"Fundamentals of Photonics" B.E.A. Saleh and M.C. Teich. Wiley, 1991.

Additional books:
"Fundamentals of Optics" F.A. Jenkins and H.E. White, McGraw-Hill 1995.
"Optics" E. Hetch. Addisson Wesley 2002.
"Optics and Photonics. An Introduction" F.G. Smith, T.A. King and D. Wilkins, Wiley 2007.
"Introduction to Color Imaging Science" H-S Lee. Cambridge 2005.

Additional information:

Javier Romero
University of Granada
E-mail: jromero@ugr.es
Office hours**:** Monday to Thursday 9 to 17hrs, or by appointment.

Youcef Ouerdane & Nathalie Destouches-Castagna
University Jean Monnet
E-mail: ouerdane@univ-st-etienne.fr; nathalie.destouches@univ-st-etienne.fr
Office hours: By appointment

Home page: *http://www.master-erasmusmundus-color.eu/*