Advanced Physics

Academic Year: (2019 / 2020) **Review date: 16/05/2020 18:52:53**

Department assigned to the subject: Physics Department

Coordinating teacher: LOPEZ MARTINEZ, FERNANDO

Type: Electives ECTS Credits : 3.0

Year : Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

PHYSICS

OBJECTIVES

Students should acquire the fundamentals of Applied Optics and different skills and abilities in this area.
Understanding these basics will allow them in turn to acquire the skills necessary to apply the optical models to simple problems resolution. In particular, those corresponding to wave optics, geometrical optics and quantum optics (light as photons accumulation).
At the completion of this topic, students must understand the basic phenomena involved in the interaction of light and matter, their dependence on the wavelength and the properties involved in the generation, transmission and detection of light. Also students must understand the basics of the huge number of applications based on optics and photonics. 3D vision, micro and nano technologies in optics, infrared vision, remote sensing, scientific understanding of global warming,...
Finally, after acquiring a well-founded basic knowledge, the students also acquire the ability of understanding and using future developments and further applications arising in the changing world of Photonics.

DESCRIPTION OF CONTENTS: PROGRAMME

I. WAVE OPTICS

1.1 Introduction to wave optics
- Nature of light. Electromagnetic spectrum
- Wave parameters. Energy and Intensity. Poynting`s vector
- Wave Equation of EM Field. Solutions
- Light Propagation in free media
- Introduction to wave phenomena

1.2 Superposition of light waves
- Same and Different Frequency.
- Phase and group velocity. Beats
- Stationary Waves
- Pulses and wave packets and trains.
- Coherence in wave optics. Spatial and Temporal
- Extended Sources

1.3 Interference and interferometers
- Constructive and Destructive Interference
- Contrast, Visibility.
- Interference by Wavefront Division. Young`s slit
- Interference by Division of Amplitude. Thin Films
- Interferometers. Michelson

1.4 Diffraction
- The Principle of Huygens-Fresnel

- Fraunhofer and Fresnel diffraction
- Diffraction by single and multiple slits
- Optical instruments resolving power. Rayleigh criterion. Airy Disk

II. GEOMETRICAL OPTICS

2.1 Introduction to Ray Optics
- Wave propagation: wavefront and Huygens' principle.
- Wave propagation: rays
- Optical systems and imaging
- Imaging by reflection and refraction
- Real and virtual images
- Total Internal Reflection
- Fermat¿s principle

2.2 Mirrors
- Imaging by reflection: mirrors.
- Flat Mirrors. Equation of distances. Lateral magnification equation
- Multiple plane mirrors.
- Spherical Mirrors: concave mirror.
- Paraxial approximation. Equation of distances. Lateral magnification equation.
- Focus of a spherical mirror.
- Spherical aberration.
- Convex spherical mirrors.
- Chief ray tracing.
- Applications.

2.3 Lenses and prisms
- Imaging by refraction.
- Refraction at a spherical surface. Paraxial approximation. Distances and lateral magnification equations.
- Thin converging lenses.
- Paraxial approximation. Distances and lateral magnification equations
- Lens foci. Focal length.
- Lensmaker´s equation.
- Diverging thin lenses.
- Principal ray tracing
- Aberrations. Aberration correction.
- Fresnel Lens.
- Prisms.
- Applications

2.4 Simple optical systems.
- The human eye: optical properties,
- Imaging: The process of accommodation.
- Vision defects: myopia and hyperopia.
- Correction by lenses.
- Correction by laser surgery.
- Photographic camera: optical elements: objective, sensor array, aperture, shutter and prism.
- Depth of field.

III. Interaction Light - Matter. Applications

3.1 Light-Matter Interaction. Basic phenomena Emission, absorption, reflection, refraction, scattering, luminescence.
- Electron as oscillator.
- The Lorentz model.

3.2 Emission Scattering and Absorption
- Emission by a thermal source.
- Scattering and absorption cross sections.

- Origin of the refractive index.
- Optical materials.

3.3 The Black Body
- Black Body Radiation. Planck's law.
- Radiometric and photometric magnitudes.
- Radiometry.

3.4 Radiation sources and detectors
- Photodetection. Sources of radiation
- Electro-Optical Systems
- Example: The infrared camera

LEARNING ACTIVITIES AND METHODOLOGY

-In the lectures the theoretical concepts previously described, will be discussed.
- Given the advanced nature of the subject, when methodologically appropriate, problems solving and questions, similar to those of the exams, in order to:
Identify the more important Optics and the light-matter interaction laws involved. Analyze the logic of the result obtained: orders of magnitude, relate the most important conclusions to other scientific and technological subjects involved in advanced optics
- Tutorial sessions will be schedule throughout the course, available to students at will. These sessions must be requested in advance

ASSESSMENT SYSTEM

% end-of-term-examination/test:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

REGULAR EVALUATION WILL BE DONE BY MEANS OF 2 EXAMS, ONE FOR EACH PART. A MAXIMUM OF 50 POINTS WILL CORRESPOND TO THESE 2 EXAMS ALL TOGETHER. A PART OF THESE POINTS CAN BE OBTAINED BY MEANS OF EXERCISES OR OTHER COMPLEMENTARY ACTIVITIES.
THE REST OF 50 POINTS MAXIMUM WILL BE OBTAINED IN THE FINAL EXAM AT THE END OF THE SEMESTER.
FOR PASSING, A FINAL MARK OF 50 POINTS AT LEAST, WILL BE NECESSARY

BASIC BIBLIOGRAPHY

- E. HECHT, A. ZAJAC OPTICS, Addison Wesley, ultima disponible

ADDITIONAL BIBLIOGRAPHY

- GUENTHER, R. Modern Optics, J. Wiley & Sons, N.Y., Más reciente disponible

- R. P. Feynman. The Feynman Lectures on Physics, Millenium Edition. Basic Books, 2010