230553 - BEAMFO – Beam Propagation and Fourier Optics

Coordinating unit:	230 - ETSETB Barcelona School of Telecommunications Engineering
Teaching unit:	1022 - UAB - Universitat Autònoma de Barcelona
Academic year:	2015 - 2016
Degree:	Master's Degree in Photonics
	Erasmus Mundus Master's Degree in Photonics Engineering, Nanophotonics and Biophotonics
ECTS credits: 5	**Teaching languages:** English

Academic staff

Coordinator:	Juan Campos (UAB)	juan.campos@uab.es
Other professors:	Salvador Bosch (UB)	sbosch@ub.edu

Degree competences to which the subject contributes

Transversal:

1. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

2. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

3. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.

4. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

Teaching methodology

Lectures

Objectives and short description of the course

The subject will address the basics of geometrical optics, intermediate topics of electromagnetic optics, polarization of light and anisotropic media, the fundamentals of light beam propagation and elements of Fourier optics, including concepts of digital holography.

The aim is to develop several topics (which are key for the future subjects of the Master) that usually are not covered in previous physics or engineering courses.

Study load

Total learning time: 125h	Hours large group:	37. 5h	30%
	Hours medium group:	0h	0%
	Hours small group:	0h	0%
	Guided activity:	3.75h	3%
	Self study:	83.75h	67%

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Course index

1. Geometrical optics.

1.1. Basic concepts. Ray tracing.
1.2. Perfect and real optical systems.Aberrations.Seidel and Zernike polynomials.
1.3. Review of image forming instruments.

2. Electromagnetic optics

2.1. Propagation in media with complex refractive index.Inhomogeneous plane waves.Energy flux.
2.2. Fields near interfaces. Reflection and refraction.Fresnel equations.
2.3. Evanescent waves.
2.4. TE and TM electromagnetic waves in layered structures.Thin films.
2.5. Guided waves.

3. Polarization of light and anisotropic media

3.1. Polarization Ellipse.Jones vectors.Jones matrix.Combinations of polarizing devices.
3.2. Stokes parameters.Mueller matrices.Poincaré sphere.
3.3. Anisotropic media: Susceptibility of an anisotropic media. Wave propagation, normal modes. Index ellipsoid.Effective refraction index.
3.4. Distortion of the index ellipsoid.Pockels effect.Liquid crystals.

4. Fourier Transform

4.1. Definition and FT of some functions.
4.2. The FT as a decomposition. Wave Packets.2D FT of images.
4.3. Convolution and correlation between two functions.
4.4. Linear systems.Impulse response. Transfer function.

5. Beam propagation and focalization
5.1. Angular spectrum of plane waves.
5.2. Field propagators.
5.3. Gaussian beams. Description and properties.Transmission through a thin lens.
5.4. Other beams with particular polarization (radial, azimuthal,...)
5.5. Focusing of fields through high numerical aperture systems.

Qualification system

Homework + exam (>70%)
Attending seminars, lab visits, class attendance (<20%)
To pass the course will require a quite accessible level of knowledge but high final grades will be obtained only by demonstrating enough proficiency.

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Bibliography

- Hetch, E., Optics, Addison Wesley Longman, Inc., 1998.
- Born, M. and Wolf, E., Principles of Optics, Cambridge Univ. Press, 1999.
- Goodman, J. W., Introduction to Fourier Optics. McGraw-Hill, 1968.
- Keigo Iizuka, Elements of Photonics Volume I. John Wiley & Sons. 2002
- Saleh B., Teich M., Fundamentals of Photonics. John Wiley & Sons. 2007
- Novotny L., Hecht B., "Principles of nanooptics", Cambridge University Press, 2006.
- Goldstein D., "polarized light", Marcel Dekker, 2003.