DIPARTIMENTO DI SCIENZE DI BASE
E APPLICATE PER L' INGEGNERIA

SAPIENZA
UNIVERSITÀ DI ROMA

ACADEMIC YEAR 2021-2022

Program of *OPTICS*

Prof. Eugenio FAZIO

Electromagnetic waves and light

Maxwell equations and EM wave equation. Spherical and plane waves. Frequencies and wavelengths of EM waves. Microscopical interpretation of the refractive index. Active and reactive polarisation and the complex refractive index. Sellmeyer equation for the refractive index dispersion. Abbe number and Abbe space for glasses. Poynting vector and light energy. Lightning quantities.

Reflection and refraction

Fermat "minimal action" principle and Snell Law. Fresnel coefficients. Critical angle and total reflection regime. Evanescent waves and Goos-Hänchen phase shift. Geometrical interpretation of optical fibres and waveguides.

Geometrical Optics

Short wavelength approximation. Reflection and mirrors. Refraction and dioptric surfaces. Thin lenses. Thick lenses and principal planes. Centred optical systems. Pupils/stops/f-number/numerical aperture. Vignetting and *cosine-to-the-fourth-power* law. Principal optical aberrations. Chromatic aberration and Achromatic doublet. Fundamental refractive systems. Ray-tracing and ABCD matrices.

Interference and interferometers

Interference of 2 co-propagating waves. Wave beating. Continuous waves and pulses. Phase and group velocities. Spatial and temporal interference. Young's experiment. Interference of 2 contra-propagating waves: stationary waves and resonators. Fabry-Perot resonator. Optical fibres as transverse resonators. Multilayer interferent systems. Design of dielectric mirrors and band-pass filters. Michelson and MachZehnder interferometers.

Diffraction

Huygens-Fresnel principle and integral. Near field regime and Fresnel Integral. Far field and Fraunhofer integral. Diffraction from a slit. Focusing limit of a lens. Diffraction from a stop. Diffraction from a grating. Harmonic and anharmonic gratings. Nano-optics.

Anisotropic optics

Anisotropic crystals. Index Ellipsoid. Uniaxial and biaxial crystals. Dichroism. retardation plates.

Nonlinear Optics

Nonlinear response. Anharmonic oscillator. Second order effects. The nonlinear optical tensor. Optical harmonic generation. Parametric effects. The Pockels electro-optic effect. Electro-optic modulators. Photorefractivity and self-assembling optical structures. Spatial solitons and solitonic waveguiding. Smart systems, Machine Learning and Photonic Artificial Intelligence.

GENERAL INFORMATION

- **e-mail**: eugenio.fazio@uniroma1.it
- **Reception for explanations**: for an explanation meeting on unclear points send an e-mail (write RICEVIMENTO in the object)

- **Information on the course**: http://www.sbai.uniroma1.it/users/fazio-eugenio and on GOOGLE CLASSROOM: course code **6fisxif** (register with the institutional e-mail address: surmane.matricola@studenti.uniroma1.it)

Books:
F. Gori, *Elementi di Ottica*, ed. Accademica
P. Mazzoldi/M.Nigro/C. Voci, *Elementi di Fisica-Onde*, EdiSES
K.D. Moller, *Optics*, Springer
A. Yariv, *Quantum Electronics*, John Wiley & Sons
Wyszecki & Stiles, *Color Science*, Wiley Classics Library
H. Zappe, *Fundamentals of Micro-Optics*, Cambridge University Press

CLASS SCHEDULE – aula 17 @ San Pietro in Vincoli Faculty (Via Eudossiana 18)	
WEDNESDAY	**15:00 - 17:00**
THURSDAY	**10:00 - 13:00**

EXAMS

SUMMER SECTION	JUNE 12, 2023	BOOKING DEADLINE ON INFOSTUD: JUNE 11, 2023
	JULY 10, 2023	BOOKING DEADLINE ON INFOSTUD: JULY 9, 2023
FALL SECTION	SEPTEMBER 4, 2023	BOOKING DEADLINE ON INFOSTUD: SEPTEMBER 3, 2023

MASTER Thesis: topics for stages are available on request on the following topics: plasmonic artificial intelligence; all-optical machine learning; photonic psyco-memories; optical recognition of viruses and bacteria; fluidic nanoparticle traps and optical recognition. Please contact the professor for details.