Faculty of matter Sciences and Computer Science
Department of Physics – L2_Physics ST-SM-ENG
Exercise Series of Geometrical and Physical Optics, 2024-2025
Exercise Series Number 2: Physical Optics_Part 1

Exercise 01 :

A laser emits red radiation with a wavelength of $\lambda_1 = 0{,}6329923 \pm 10^{-7}\ \mu m$. Calculate the wavelength λ_2 of the radiation emitted into the air of index $n_2 = 1{,}00028 \pm 10^{-5}$.

Exercise 02 :

We consider a source point O emitting a monochromatic light wave in a homogeneous, isotropic and transparent medium. The electric field at the source point is written:

$$E(O,t) = E_0 \cos(\omega t)$$

1. What is the shape of wave surfaces?
2. Give the expression of the wave surface whose phase difference with the source is φ.
3. How do you get a plane wave with a point source?

Exercise 03 :

Let be an electromagnetic wave placed in a vacuum whose electric field is given by:

$$\begin{cases} E_x(z,t) = 10^2 \sin \pi(3.10^6 z - 9.10^{14} t) \\ E_y(z,t) = E_z(z,t) = 0 \end{cases}$$

1. Give the amplitude of this wave, its direction of propagation and its polarization.
2. Determine its speed, wavelength and frequency. What color of light is it?
3. Write the expression of the magnetic field $\vec{B}$ associated with this wave.

Exercise 04 :

Let be two parallel waves of the same real amplitude a and the same pulsation ω

$$\psi_1 = a \cos \omega t \quad ; \quad \psi_2 = a \cos(\omega t + \varphi)$$

1. Show that the resulting wave is the superposition of the two waves $\psi = \psi_1 + \psi_2$ can be written in the form $\psi = A \cos(\omega t + \alpha)$. Determine A and α. Find this result using the complex representation.
2. Knowing that the intensity is proportional to the amplitude squared. Give the resulting intensity in the following cases :
   a. The two waves are in phase.

b. The two waves are in phase opposition.

c. The two waves are in phase quadrature.

Exercise 05 :

Two slits are used at a distance of $0.2\ mm$ from each other and the projection of the interference is at $1.0\ m$. The third bright fringe (the central fringe is not taken into account $k = 0$) is located $9.49 mm$ from the central fringe. Measure the wavelength of the light in this case.

Exercise 06 :

Two Young's slits are separated by a distance of $0,2\ mm$. The observation screen is distant from $1\ m$.

1. The 3rd bright fringe is located $7.5\ mm$ from the central fringe. Calculate the wavelength of the light used.
2. Same question assuming that it is the 3rd dark fringe that is $7.5\ mm$ from the central fringe.

Exercise 07 :

We use the scalar model of light. Let be $S_1(M,t)$ and $S_2(M,t)$ the amplitudes of two synchronous monochromatic waves received at any point M of the interference field : $S_1\ (M,t) = S_{01} expj(\omega t - \varphi_1)$, $S_2(M,t) = S_{02} expj(\omega t - \varphi_2)$, phases φ_1 and φ_2 and depend on the position of the point M. We observe in a plane parallel to the plane containing the two sources at a distance D from the two large sources.

1. Give the expression of $I(M)$ in function of $I_1(M)\ et\ I_2(M)$, intensities of each wave, and of the phase shift $\varphi = \varphi_2 - \varphi_1$.

2. Under what conditions are light interferences observed in M ?

3. Specify the orientation of the fringes and determine the interfringe.

4. We note I_0 the common value at $I_1(M)$ and $I_2(M)$. Plot $I(M)$ as a function of the phase shift φ.

5. For which values of φ is the intensity maximum? We will take λ = 0.546μm.