Homework #4
OPTI 370
2/2/2022
(due date: 2/9/2022)

Problem 1:

In the last homework assignment, you determined the Fourier transform of the function

$$f(x) = \mathrm{rect}(x)$$

Now assume you want to analyze a pulse with rectangular shape and width $\sigma_t = 413\ \mu\mathrm{s}$. Using the same strategy shown in class, namely writing the argument of the rect function as $x = t/\sigma_t$, using the result from last week's homework or Tab. A.2-1 of the book, and using the definition of the spectral width of a sinc function given in class, determine the spectral width of the given pulse. How does the spectral width change if you double the pulse's duration σ_t ?

(10 points)

Problem 2:

Consider a monochromatic wave of frequency $\nu = 53\,\mathrm{THz}$ and amplitude a=0.98 (units of $W^{1/2}$/cm) travelling in z-direction in a medium of length $d = 24.5\mathrm{cm}$, characterized by the absorption coefficient $\alpha(\nu) = 0.079\mathrm{cm}^{-1}$ and refractive index $n(\nu) = 1.24$. The wave is given by

$$u(z,t) = a\cos(\omega t - k\,z)\,e^{-\frac{1}{2}\alpha(\nu)\,z}$$

Write down the corresponding complex wave functions $U(z,t)$ (which includes the time dependence) and $U(z)$ (which does not include the time dependence) . Determine the wavelength in vacuum and in the medium, as well and input and output intensity. Plot the intensity as function of z.

(10 points)

Problem 3:

Consider a monochromatic wave of frequency $\nu = 548$ THz and amplitude a=0.46 (units of $W^{1/2}$/cm) travelling in z-direction in a medium of length $d = 13.2\mathrm{cm}$, characterized by the gain coefficient $\gamma(\nu) = 0.081\,\mathrm{cm}^{-1}$ and refractive index $n(\nu) = 1.35$. The wave is given by

$$u(z,t) = a\cos(\omega t - k\, z)\, e^{\frac{1}{2}\gamma(\nu)\, z}$$

Write down the corresponding complex wave functions $U(z,t)$ (which includes the time dependence) and $U(z)$ (which does not include the time dependence) . Determine the wavelength in vacuum and in the medium, as well and input and output intensity. Plot the intensity as function of z.

(10 points)

Problem 4:

Consider a monochromatic oscillation with frequency $\nu_0 = 597$ THz. Let the Fourier transform of $U(t)$ be $V(\nu) = (a + jb)\,\delta(\nu - \nu_0)$ with a=9.6 and b=6.2 (units of $W^{1/2}$/cm). Determine the complex amplitude $U(t)$, the real-valued oscillation $u(t)$, and plot the latter over at least two optical cycles. Also, determine the intensity of the oscillation. Does the intensity change with time?

(10 points)