Task 1.

Huygens nanoantenna.

Calculate the dependence of the maximum directivity D_{max} on the frequency in the range of wavelengths 500-750 nm for a system consisted of a small (quasi-point) dipole located near a silicon cylinder. The radius of the cylinder is r = 120 nm, and the height h = 100 nm. Cylinder's axis is pointed along z direction. Material of the cylinder is Silicon Crystalline (optical) (loaded from the base). Dipole is located on the cylinder's axis and shifted from the center of the cylinder by $a = h/2+30$nm; dipole is oriented orthogonally to the cylinder's axis. Calculate the ratio of the intensity of the wave emitted in forward direction (direction along the cylinder's axis from dipole to cylinder) to the intensity of the backward emission (direction along the cylinder's axis from cylinder to dipole) for the same frequency range.

Task 2.

Material with negative refractive index.

Create a material that has both negative permittivity and permeability and small losses. At frequency 400 THz $\varepsilon=\mu=-2$, at frequency 300THz $\varepsilon=\mu=-1$. Create a plate made of such material, surrounded by two semi-infinite layers of vacuum. Calculate the field distribution and reflection/transmission coefficients at this frequencies for two angles of incidence $\theta = 0$, $\theta = \pi/3$. Check that the refraction index and the phase velocities of the waves inside the plate are negative.