UNIVERSITÀ
DEGLI STUDI
DI BRESCIA

Student ID:
First Name:
Last Name:

Instructions: You have 1.5 hours to complete the test. If you need extra blank sheets to complete the test please ask. Please write everything with blue or black ink pen. You can use your calculator. Use of cell phone, course notes or personal computer will invalidate the results of the test. If you don't have a calculator, you can leave the formulas in expression forms and still get full score for the questions/exercises.

Questions:

1. A monochromatic plane wave of angular frequency ω propagates in a linear, isotropic, homogeneous medium with permittivity ϵ and permeability μ. Assume that the wave propagates along the positive z-axis direction of a system of Cartesian coordinates (x,y,z), i.e., the wavevector is $\boldsymbol{k} = k\hat{\boldsymbol{z}}$.

   - Write the dispersion relation and the phase velocity of this plane wave.
   - If the electric field of this plane wave is linearly polarized along the x-axis, what is the direction of the magnetic field vector $\boldsymbol{H}$?

2. An optical element has the following Jones matrix representation:
$$M = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$$
   What kind of element is it?

3. A glass sphere has radius a = 5 nm and is illuminated with green light ($\lambda \sim$ 500 nm). Can we expect to observe Rayleigh or Mie scattering from the glass sphere? Motivate the answer.

4. A diffraction grating has 12,600 slits uniformly spaced over 25.4 mm. It is illuminated at normal incidence by yellow light from a sodium vapor lamp. This light contains two closely spaced lines (the well-known sodium doublet) of wavelengths 589 nm and 589.59 nm. At what angle will the first order maximum occur for the first of these wavelengths (589 nm)?

5. What is a metasurface and what kind of optical components can replace?

6. Describe a scanning probe technique of your choice.