UNIVERSITÀ DEGLI STUDI DI BRESCIA

Nanophotonics Midterm Test
April 10, 2018

Student ID:
First Name:
Last Name:

Instructions: You have 2 hours to complete the test. There are 10 questions/problems and each one is valued 3 points. 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 exercises.

Questions:

1. Define the difference between an isotropic and an anisotropic medium.
2. Define the phase velocities in a uniaxial crystal with ordinary refractive index n_o and extraordinary refractive index n_e?
3. An hypothetical metal has a permittivity that can be described with a single Drude oscillator with plasma frequency $\omega_p=10^{15}\ s^{-1}$ and damping coefficient $\gamma = 10^{13}\ s^{-1}$. Find the real and imaginary part of the permittivity when $\omega=\omega_p$.
4. Verify that a circular polarizer whose Jones Matrix is $\frac{1}{2}\begin{bmatrix} 1 & i \\ -i & 1 \end{bmatrix}$ is completely transparent to one type of circularly polarized light and blocks completely the opposite circular polarization.
5. The critical angle for total internal reflection of a certain substance is exactly 45°. What is the Brewster angle for the same substance?
6. A glass sphere has radius a = 5 nm and is illuminated with green light (λ ~ 500 nm). Can we expect to observe Rayleigh or Mie scattering from the glass sphere? Motivate the answer.
7. Calculate reflectance and transmittance at normal incidence (θ_I = 0°) when the light goes from air (n_a=1) to water (n_w = 1.33).
8. Calculate the angle of diffraction of the first and second order (m = 1 and m = 2) for a grating with periodicity *d* = 700 nm illuminated with a plane wave at normal incidence with λ = 495 nm.
9. A 1D photonic crystal is composed of two materials having permittivities ε_1=1 and ε_2=4. Calculate the mid-gap wavelength assuming the periodicity of the stack equal to *a* = 225 nm.
10. Determine the angle of incidence θ_I of a TM-polarized plane wave required to excite a surface plasmon at the air-silver interface in the Kretchmann configuration (see picture below). Assume the incident wavelength λ=532nm and the permittivity of silver at the same wavelength ε_m = -9.30 + i 0.5. The prism has permittivity ε_{glass} = 1.5.