UNIVERSITÀ DEGLI STUDI DI BRESCIA

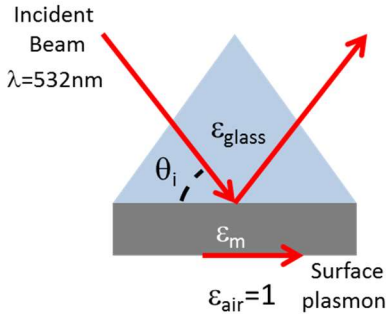
Nanophotonics Final Test
June 9, 2020

Student ID:
Name:
Instructions: You have 1.5 hours to complete the test. Please write everything with blue or black ink pen so that all your work can be read easily. You can use your calculator. If you don't have a calculator, you can leave the formulas in expression forms and still get full score for the questions/exercises. Use of course notes or internet resources will invalidate the results of the test. Use of your cell phone is allowed only for scanning test and emailing the file at the end of the exam.
VERY IMPORTANT: Please WRITE YOUR FULL NAME AND STUDENT ID on the first sheet you scan. If you forget to include your name, I will not be able to put your material on record and therefore the test will NOT BE VALID!

Questions:

1. A plane wave crosses a boundary, located at z=0, between a medium 1, which occupies the half space z<0 and it has refractive index n_1, and a medium 2, which occupies the z>0 half space and it has refractive index $n_2 = \frac{n_1}{3}$.
   a. What is the value of reflectance R and transmittance T if the angle of incidence is equal to 0 (i.e., normal incidence)?
   b. Suppose the plane wave crosses the boundary going from medium 1 to medium 2 at oblique incidence. What condition should the plane wave satisfy to observe a zero in reflectance? What is the value of Brewster's angle at this boundary?
   c. Suppose the plane wave crosses the boundary going from medium 1 to medium 2 at oblique incidence. What is the value of critical angle at this boundary?
   d. Total internal reflection occurs when light, crossing the boundary from medium 1 (z<0) to medium 2 (z>0), is obliquely incident above the critical angle. Explain why, under these circumstances, the electric field is not equal to zero in medium 2.

2. Describe how to obtain circularly polarized light from unpolarized light. You can use a drawing to support your explanation.
3. Determine the angle of incidence θ_i of a TM-polarized plane wave required to excite a surface plasmon at the air/metal interface in the Kretschmann configuration (see picture below). Assume the incident wavelength λ = 532 nm and the permittivity of silver at the same wavelength ε_m = -9.3 + i 0.5. The prism has permittivity ε_{glass} = 2.25. Calculate the propagation length of the surface plasmon at the air/silver interface.



4. Describe a scanning probe technique of your choice.