UNIVERSITÀ DEGLI STUDI DI BRESCIA

Nanophotonics Final Test
June 23, 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 polarizer is an optical element that transforms unpolarized or partially-polarized light into polarized light.
   a) Briefly describe how you can use a linear polarizer and a detector to measure the degree of polarization.
   b) Define linear, circular and elliptical polarization for a plane wave. Suppose the plane wave travels along the z-direction in free space, therefore the electric-field vector lies in the xy plane and it can be written, in complex notation, as $\boldsymbol{E} = (a_x\hat{\boldsymbol{x}} + a_y e^{j\phi}\hat{\boldsymbol{y}})e^{-jk}$.
   c) An optical element has the following Jones matrix representation:

$$M = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$$

   What kind of element is it? Motivate your answer.

2. A diffraction grating is surrounded by air and 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 λ_1 = 589 nm and λ_2= 589.59 nm. At what angles will the first order diffraction maxima occur for λ_1 and λ_2?

3. Describe what a surface plasmon polariton is and how to excite it via prism coupling.

4. An object is placed on the left hand side of a slab made of a right-handed medium [Figure 1.(a)] and a left-handed-medium [Figure 1.(b)]. Using the ray theory, draw the refraction of light at each interface in the two scenarios.

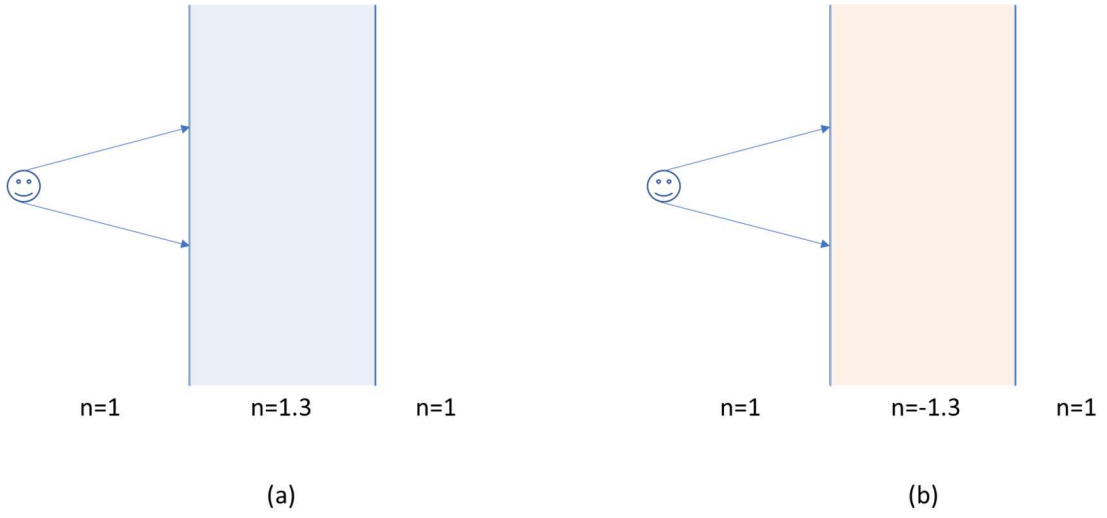

Figure 1