UNIVERSITÀ DEGLI STUDI DI BRESCIA

Photonics Final Test
June 22, 2022

Student ID:
Name:
Instructions: You have 2 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. Use of course notes or internet resources will invalidate the results of the test.
VERY IMPORTANT: Please WRITE YOUR FULL NAME AND STUDENT ID on this sheet and all your sheets where the problems are solved!

Questions:

1. A 4 cm tall light bulb is placed at 45.7 cm from a concave mirror having a focal length f= 15.2 cm. Determine the image distance and the image size and draw object and image position and orientation (upward or downward) with respect to the mirror.

2. 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? What happens to transmittance and reflectance for angles of incidence greater than the critical angle?

3. An optical element has the following Jones matrix representation:

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

Is this element:

A. A quarter-wave plate?
B. A circular polarizer?
C. A linear polarizer?
D. A half-wave plate?

Motivate your answer.

4. Briefly describe what a surface plasmon polariton is. Then compare the phase velocity of a surface plasmon propagating at a flat air-silver interface λ=532nm with the phase velocity of light in air. Is the surface plasmon slower or faster than light in air? Assume the dielectric constant of silver at λ=532nm is ε_{Ag}=-9.3-j0.05 whereas the permittivity of air is ε_{Air}=1.