VS203B
Midterm Exam Version A
Dr. Roorda
Date: April 27, 2010
Permitted aids: pens/pencils, eraser, ruler, calculator
This exam is out of 38 points

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1. (1 point) Choose the **one** correct answer. Light is modeled as a transverse wave and not a longitudinal wave….
a) so that it can get through a narrow slit aperture.
b) to properly explain how it can interfere from a thin film coating.
c) to properly explain phenomena related to polarization.
d) because a transverse wave can travel in all directions, whereas longitudinal waves can only travel in one direction.

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2. (1 point) If you observe a fringe pattern generated by 632 nm light on screen held 2 m from a double slit aperture, and the fringes are 2 cm apart, then what is the separation between the slits?
a) 6320 microns
b) 632 microns
c) 63.2 microns
d) 6.32 microns

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3. **(1 point)** What is the optimal thickness for a magnesium fluoride (index of refraction = 1.38) coating on polycarbonate (n=1.6) to reduce reflections of 550nm infrared light?
a) 85.9 nm
b) 99.64 nm
c) 171.9 nm
d) 199.3 nm

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4. **(1 point)** What is the optimal thickness for a magnesium fluoride (index of refraction = 1.38) coating on Schott glass (n=1.5) to reduce reflections of 550nm infrared light?
a) 91.7 nm
b) 99.64 nm
c) 183.3 nm
d) 199.3 nm

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5. (1 point) A light source with a coherence length of 0.1 mm is used to illuminate a double slit aperture. The slit separation is 1 mm and the screen is held at a distance of 2 m. What is the maximum distance from the axis on the screen for which Young's double slit interference fringes could still be observed?

a) 40.2 cm
b) 20.1 cm
c) 5.74 cm
d) 0.35 cm

6. (1 point) When a -8D myope looks through his spectacle lens (index = 1.5) leftward at an angle of 15 deg, which of the following correctly describes the effective power of this lens when looked through in the manner described above?

a) -8.46 DS, -0.55 DC, axis 180
b) -8.46 DS, -0.55 DC, axis 90
c) -8.73 DS, -0.73 DC, axis 180
d) -8.18 DS, -0.55 DC, axis 90

7. (1 point) In the situation described above, which axis is the saggital axis?

a) Vertical
b) Horizontal
c) Both
d) Neither

8. (2 points total) Indicate whether the following statements are true (T) or false (F) (0.5 points each)

T F Fraunhofer diffraction methods can be used to explain the intensity distributions that occur at the focal point of a lens.

T F Fraunhofer diffraction methods are used to explain intensity distributions generated from small apertures, whereas Fresnel diffraction methods need to be used to explain intensity distributions generated from larger apertures.

T F Fresnel diffraction must be used whenever polychromatic light is used to illuminate an aperture.

T F Huygens principle states that any point along a propagating wave can be considered as a new point source radiating light in the forward direction.

9. (4 points total) For two mutually coherent light waves, traveling through glass with an index of refraction of 1.5, the coherent intensity of the two waves at a point in space is 46.55% of the input light (fraction of 0.4655). Use this information to fill in every blank in the two equations below. (*all numbers are in units of radians*)

$$E_1 = 0.2 \times \sin\left(\_\_\_\_\_\ x - 3.543 \times 10^{15} t\right)$$

$$E_2 = 0.5 \times \sin\left(\_\_\_\_\_\ x - \_\_\_\_\_\ t + \_\_\_\_\_\right)$$

10. (6 points total) You have a ultra-thin, wedge prism that is 3 microns thick at its base, made of a material with an unknown index of refraction. When you hold the prism in air and look at 550 nm reflecting off its surface, you observe 17 dark, non-reflective fringes (called fringes of equal thickness). The first and last dark fringes occur at the apex and the base of the prism. What is the refractive index of the material?

12. (4 points total) Consider Young's double slit experiment, like you did in the lab and like we discussed in the lecture. The intensity pattern contains fringes that are completely black. The ratio between the peak intensity and the minima is therefore infinite. Now, consider a situation where one of the slits has a filter in front of it that blocks 50% of the light (50% transmitted intensity). What will be the ratio between the peak and minimum intensity?

11. (10 points total) You want to construct a coating that minimizes reflection of 600 nm light from a glass of index 1.5, and you have a coating material with an index of refraction of 1.3.

a) (2 points) What thickness do you make the coating?

b) (4 points) What is the percentage of reflected intensity of the surface for 600 nm light?

c) (4 points) What is the percentage of reflected light for 500 nm?

14. (5 points) Design an achromatic doublet comprised of CR39 Hard Resin Plastic (refractive efficiency = 58.0) and polycarbonate (refractive efficiency = 30.0) that has a power of -11 D.