Physics Dept.
AUB

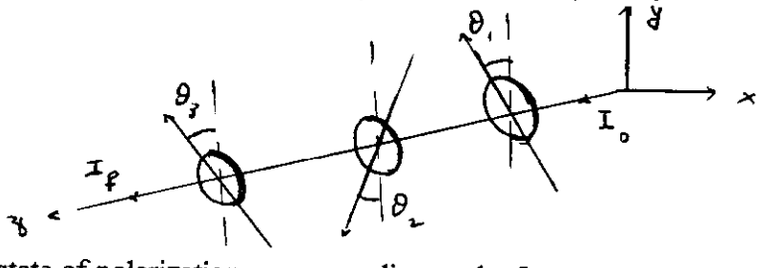
Physics 223
FINAL EXAM

June 23, 1998
Time: 3 hours

1) Unpolarized light is reflected from a plane surface of fused silica glass of index 1.458.
   a) Determine the critical and polarizing angles θ_c , θ_p and θ'_p .
   b) Determine the reflectance and transmittance for the TE mode at normal incidence and 45° .
   c) Repeat b) for the TM mode
   d) Calculate the phase difference between TM and TE modes for internally reflected rays at angles of incidence of 0°, 40°, 70°.

2) Calculate the penetration depth of an evanescent wave undergoing total internal reflection at a glass (n = 1.50) - to - air interface, such that the amplitude is attenuated to 1/e its original value. Assume light of wavelength 500 nm is incident at the interface with an angle of 60°.

3) In the figure below, initially unpolarized light is sent through three polarizing sheets whose polarizing directions make angles of $\theta_1 = \theta_2 = \theta_3 = 50°$ with the direction of the y-axis. What percentage of the initial intensity is transmitted by the system of the three sheets?



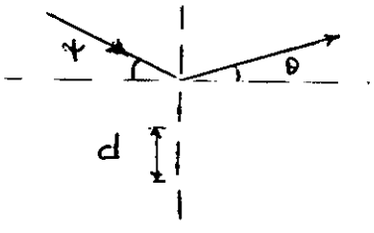
4) a) Identify the state of polarization corresponding to the Jones vector

$$\begin{bmatrix} 2 \\ 3e^{i\pi/3} \end{bmatrix}$$

and write it in the standard, normalized form.

   b) Let this light be transmitted through an element that rotates linearly polarized light by +30° . Find the new, normalized form and describe the result.

5) A grating with d = 1.50 μm, is illuminated at various angles of incidence by light of wavelength 600 nm. Plot, as a function of the angle of incidence (0 to 90°) the angular deviation of the first-order maximum from the incident direction.



6) A diffraction grating has 1.26×10^4 rulings, uniformly spaced over width w = 25.4 mm. It is illuminated at normal incidence by blue light of wavelength 450 nm.
   a) At what angles to the central axis do the second-order maxima occur?
   b) What is the half-width of the second-order line/
   c) If yellow-light from a sodium vapor lamp is used of wavelengths λ_{y1} = 589.00nm and λ_{y2} = 589.59 nm, what is the angular separation between the two first order lines ?
   d) How close in wavelength can two lines be and still be repaired by this grating in the first and second order if a yellow light of λ_{y1} = 589.00 nm is used.
   e) How many rulings must a grating have to just resolve the sodium lines λ_{y1} and λ_{y2} in the first order?

7) The radius of curvature of the convex surface of a plane-convex lens is 30 cm. The lens is planed with its convex side down on a plane glass plate, and illuminated from above with red light of wavelength 650 nm.
Find the diameter of the third dark ring in the interference pattern.

8) Monochromatic parallel light impinges normally on an opaque screen with a circular hole of radius r and is detected on the axis a distance L from the hole. The intensity is observed to oscillate as r is increased from 0 to ∞ .
   a) Find the radius r_a of the hole for the first maximum.
   b) Find the radius r_b of the hole for the first minimum.
   c) Find the ratio of the intensity for $r = r_a$ to the intensity for $r = r_\infty$.
   d) Suppose the screen is replaced by an opaque disk of radius r_a . What is the intensity?

9) a) Consider the Fraunhofer diffraction pattern due to two unequal slits. Let a and b be the unequal slit widths and c the distance between their centers. Derive an expression for the intensity of the pattern for any diffraction angle θ , assuming the arrangement to be illuminated by perpendicular light of wavelength λ .
   b) Use your formula from a) to obtain expression for the pattern in the following special cases and make a sketch of those patterns:
   i) a = b. ii) a=0.

10) White light, with a uniform intensity across the visible wavelength range of 400 - 690 nm, is perpendicularly incident on a water film of index of refraction n = 1.33 and thickness d = 320 nm, that is suspended in air. At what wavelength λ is the light reflected by the film brightest to an observer ?