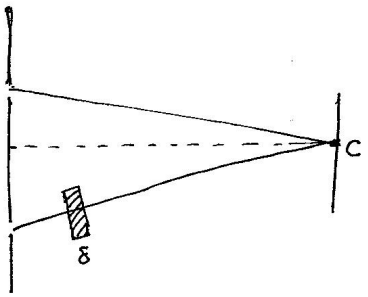
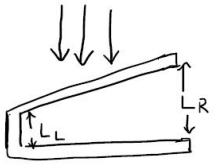
ISI B.Math : Physics II
Problem Set 4
Total Marks = 30



1. The diagram shows a double slit experiment in which monochromatic light of wavelength λ from a distant source is incident upon two slits, each of width w ($w \ll \lambda$) and an interference pattern is seen on a distant screen.
A thin piece of glass of thickness δ and index of refraction n is placed between one of the slits and the screen, and the intensity of the central point C is measured as a function of the thickness δ. If the intensity for $\delta = 0$ is given by I_0

(a) What is the intensity at C as a function of δ? (3)
(b) for what values of δ is the intensity at C a minimum?(2)
(c) Suppose that the width of one of the slits is now increased to $2w$, the other width remaining unchanged. What is the intensity at point C as a function of δ? Assume that the glass does not absorb any light (5).

2. The rhinestones in costume jewellery are glass with refractive index 1.50. To make them more reflective, they are often coated with a layer of silicon monoxide of index of refraction 2.00. What is the minimum coating thickness needed to ensure that light of wavelength 560 nm and of perpendicular incidence will be reflected from the two surfaces of the coating with fully constructive interference? (5)



3. The figure shows a transparent plastic block with a thin wedge of air at the right. A broad beam of red light with wavelength $\lambda = 632.8$ nm is directed downward through the top of the block. Some of the light is reflected back up from the top and bottom surfaces of the wedge, which acts as a thin film of air with a thickness that varies uniformly and gradually from L_L at the left to L_R at the right. An observer looking down at the wedge sees an interference pattern consisting of six dark fringes and five bright red fringes along the wedge. What is the change in thickness $\Delta L = (L_R - L_L)$ along the wedge?(5)

4 . Derive the following expression for the intensity pattern for a " three slit grating".

$$I = \frac{1}{9} I_m (1 + 4\cos\phi + 4\cos^2\phi)$$

where $\phi = \frac{(2\pi d \sin\theta)}{\lambda}$ Assume that $(b \ll \lambda)$ and I_m is the intensity of the central maximum.(5)

5. In a double-slit experiment, the wavelength λ of the light source is 405 nm, the slit separation is 19.44 μm and the slit width is 4.050 μm. Consider both interference and diffraction of light from the two slits.
(a) How many bright interference fringes are within the central peak of the diffraction envelope?(2.5)
(b)How many bright fringes are within either of the first side peaks of the diffraction envelope ?(2.5)