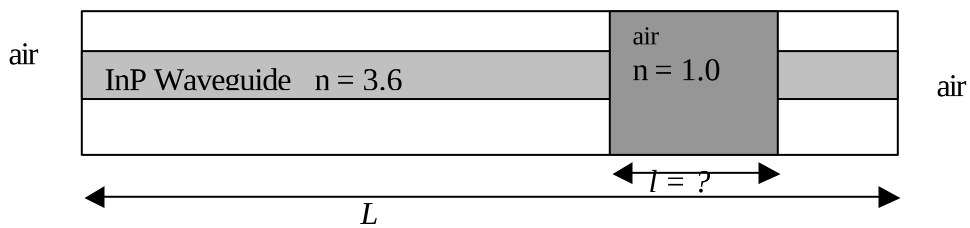
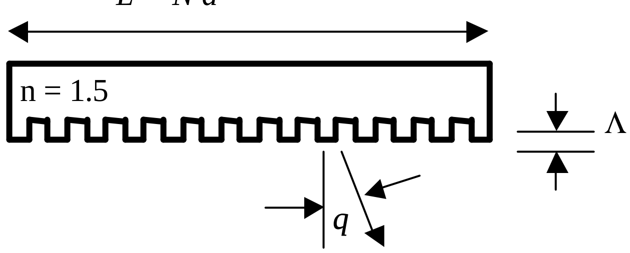
UNIVERSITY OF TORONTO
Department of Electrical & Computer Engineering
Optical Engineering - ECE 426F – 2000 Assignment 2

Due Date: flexible, up to Monday Dec. 11 at 5pm in GB254– just before Special Exam Tutorial.
Marker: Winnie Ye

1. An InP Fabry-Perot laser relies on Fresnel reflection at the output facets for its high reflectance. The laser length is 100 μm and has a peak gain coefficient of 600 cm^{-1} centered at 1.55-μm wavelength. Assume a Gaussian gain distribution of 10-nm bandwidth (FWHM).
   (a) How many modes lase?
   (b) Estimate the spectral width (in nm) of a single laser mode.
   (c) Specify a gain length and a modified mirror reflectivity that only supports one laser mode. The spectral width must remain identical to that in (b). (*Numerical solution)*
   (d) In another approach to (c), an etalon is fabricated inside the laser cavity as shown below. The etalon modes *compete* with the InP modes. Design a length, *l*, for the etalon so that only one Fabry-Perot mode will select/coincide with a single mode of the longer InP waveguide. Is there sufficient reflection at the air-InP interface for this to work properly?



2. Modify the grating diffraction formula to apply to the phase mask below for uniform illumination from above. Assume groove width, *s*, is one-half the periodic groove spacing *d*. The length of the phase mask is $L = Nd$, where *N* is the number of periods (tooth plus groove). Assume values of L = 5mm and d = 2 μm.
   (a) Derive the far-field interference formula for intensity as a function of N, d, Λ, and θ.
   (b) Specify the special condition on the groove depth, Λ, that completely eliminates the zeroth order interference peak, at $\theta = 0^o$. Simplify the result in (a).
   (c) Estimate how much of the incident power ends up in the first order interference peak for 1.55-μm light.
   (d) Wavelength-division multiple (WDM) access protocol provides 100 wavelengths near 1.55 μm with 50-GHz frequency spacing. Determine the propagation angle for first-order interference for 1.55000-μm light, and also for the next nearest channel wavelength.
   (e) Are all wavelengths resolved by the phase mask? *Hint: resolving power is l/Dl = mN.*
   (f)



3. Aluminum has a complex index of refraction ($n + i\ k$) of $n = 0.82$ and $k = 5.99$ at 546-nm wavelength. The thickness of a free-standing aluminum foil is to be specified such that normally incident light is equally split into a transmitted and a reflected beam. You must account for multi-reflections (Fabry-Perot), complex values for the Fresnel coefficients, and absorption losses in the aluminum film. In other words, repeat the Fabry-Perot derivation for both reflection and transmission by summing up the multi-reflection fields. Equating these expressions and apply an iterative procedure to specify the optimum film. Your final answer should include the film thickness, the reflectance, the transmittance, and the percent loss.

   Follow perpendicular polarization. Use computer program that handles complex numbers – Mathematica or MatLab are good.