PHYS 408 2010/11 term 2

Homework problem set #5 problems 1-4
Assigned: 11/02/2011
Written Solution due 25/02/2011 5 PM in Hennings 328
If you collaborated with anyone, please write their name at the top of your HW

This homework is worth 200 marks

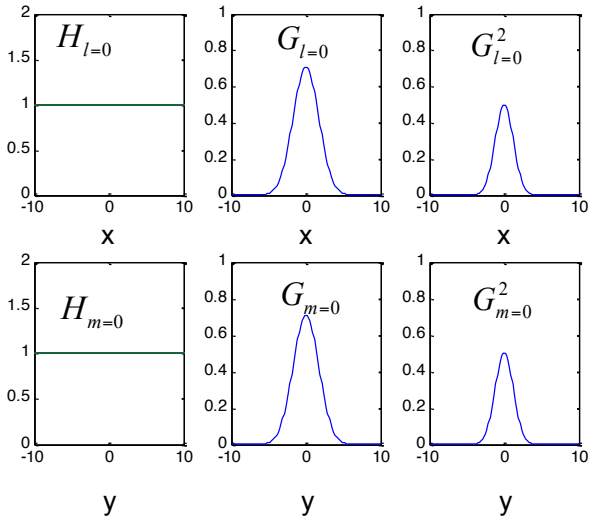
Problem 1 (40 marks) (This isn't a typo)

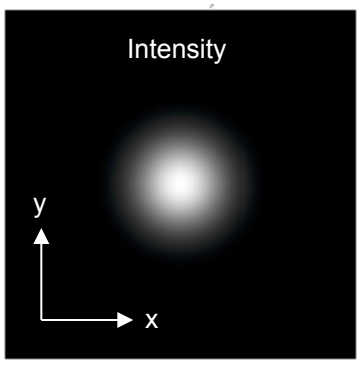
Look at the midterm solutions I posted and pick **TWO** problems that you may have gotten wrong. Describe in words what you may have done wrong and what your misconceptions were. And explain what you didn't understand and what techniques you needed to know in order to solve the problem. Explain in words what you have learned from this.

If you feel you solved all of the problems correctly, then pick a problem and try to find and explain three misconceptions that might lead a person to answer wrongly. To be an expert, you must learn to identify the possible conceptual difficulties that a person may have in order to communicate with them effectively

Problem 2 (25 Marks)
We did not cover higher order (Hermite-) Gaussian beams in class. However, you will need to understand them for your HeNe laser lab. Section 3 in chapter 3 of the text will be very helpful to you to solve this problem Chapter 6.6 of the online Steck text will also be helpful.

Similar to the table below (shown for the *l=0,m=0* case), calculate and plot the Hermite polynominals, x and y variation of the electric field, the x and y variation of intensity, and the intensity distributions for the *l=1,m=4* and the *l=6 m=7* modes with $w_o(z)$=sqrt(5) at $z=z_o$. You MUST use a computer program to do the plotting (like gnuplot, matlab, mathematica, maple, etc). Provide a copy of your code you used as well as the plots





Problem 3 (25 marks)

Shown below are the optical arrangement for reading out data from CDs, DVDs, and BDs.

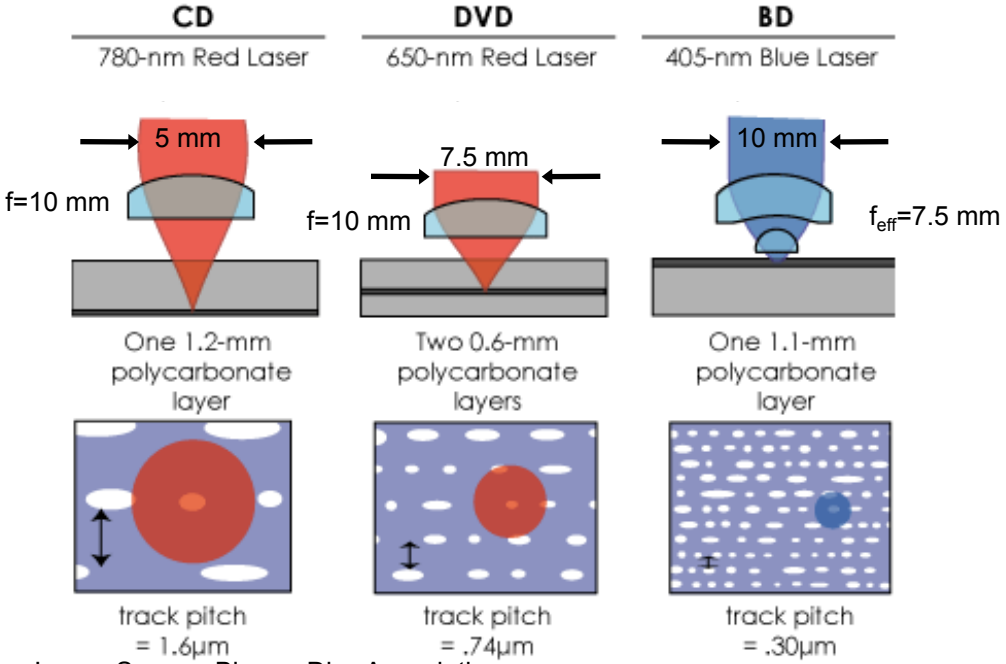


Image Source: Blu-ray Disc Association

In each case calculate the spot size of the laser on the encoding layer of the respective discs. Assume the laser is collimated at the input and remember to include the effect of the polycarbonate layer (you might need to look up its index). Does the spot size difference scale with the track pitch of the various formats and the overall data storage capacity?

Problem 4 (25 marks) This is old exam problem

A Gaussian beam ($\lambda_o = \cdot 10^{-6}, w_o = 2x10^{-3}$ both in units of meters) propagates a distance of 1.5 meters from its minimum waist location before entering an infinitely thin (meaning you can ignore any diffraction of the wave) piece of material. This material has a radial dependent amplitude transmittance of:

$$t(x,y) = 0.8 * \exp\left[-(x^2 + y^2)/10^{-6}\right]$$

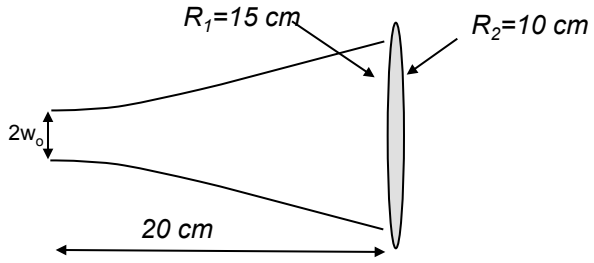
This material changes the beam parameters. Hint: *In terms of algebra, there is an easy and a hard way to approach this problem.*

Find the new divergence angle and location of new minimum waist.
Describe how you could make such a material

Problem 5 (25 marks

Problem 3.2-7 from Saleh and Teich. You may use any computer program, but include a copy of your code for full marks

Problem 5 (30 Marks) I would suggest using the q-parameter.
In this problem we are going to see how thick a "thin" lens needs to be without affecting the thin lens approximation. Using the thin lens approximation, find the new minimum waist and its location when a beam produced by an YAG laser (λ=1064nm) with w_o=4 mm passes through the lens (n=1.5) pictured below:



Now repeat this problem except that you now consider the finite thickness of the lens. Find the lens thickness T where your result of the new minimum waist size is different from the thin lens case by 10% Do this portion of the problem numerically. *HINT: look at Exercise 1.4-5 from text…but you must prove this result via ABCD, not just use the formula. You should find the thin lens approximation to be pretty good for normally used T.*

