EE 119 Homework 10

Professor: Jeff Bokor TA: Xi Luo
Due Tuesday, April 27th 2010
(Please submit your answers in EE119 homework box located in 240 Cory Hall)

1. ***Diode Lasers***
   Consider a InGaAsP-InP laser diode which has an optical cavity of length 250 microns. The peak radiation is at 1550 nm and the refractive index of InGaAsP is 4. The optical gain bandwidth (as measured between half intensity points) will normally depend on the pumping current (diode current) but for this problem assume that it is 2 nm.
   (a) What is the mode integer *m* of the peak radiation?
   (b) What is the separation between the modes of the cavity?
   (c) How many modes are within the gain band of the laser?
   (d) What is the reflection coefficient and reflectance at the ends of the optical cavity (faces of the InGaAsP crystal)?
   (c) The beam divergence full angles are 20° in y-direction and 5° in x-direction respectively. Estimate the x and y dimensions of the laser cavity. (Assume the beam is a Gaussian beam with the waist located at the output. And the beam waist size is approximately the x-y dimensions of the cavity.)

2. ***Characteristics of common lasers***
   We have discussed some of very common lasers in class. There are many other lasers which we have not covered in the lecture. In this problem, you have to do some library research on the following lasers. You have to describe their special characteristics, how these lasers are operated, and at what wavelengths it lases typically. Include diagrams to get more points.
   (a) Liquid lasers (dye lasers).
   (b) Excimer lasers.
   (c) Plasma X-ray lasers.
   (d) Free electron lasers.
   (e) VCSEL (Vertical Cavity Surface Emitting Lasers).

3. ***Fraunhofer diffraction***
   (a) Calculate and plot (two-dimension) the far field diffraction pattern of the square aperture. The aperture is 0.5mm in size and is located at 10m from the detector plane. Be sure to label x and y-axis. (λ=632.8nm)
   (b) Find an expression for the intensity distribution in the Fraunhofer diffraction pattern of the aperture shown in Fig.1. Assume unit-amplitude, normally incident plane-wave illumination. The aperture is circular and has a circular central obstruction. Outer radius is R_1 and inner radius is R_2.

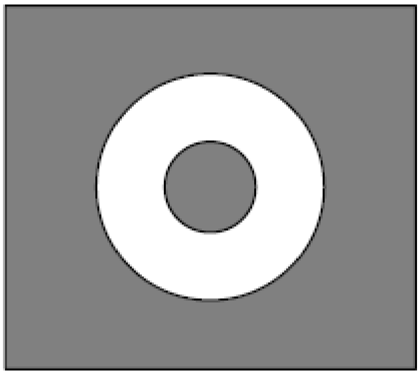

Fig. 1

(Hint: The electric field of the Fraunhofer diffraction pattern from a circular aperture is: $E(r) = e^{jkr} e^{jk\frac{r^2}{2z}} \frac{A}{jz\lambda} \left[2 \frac{J_1(kwr/z)}{kwr/z} \right]$

where J1 is the Bessel function of first order, k is a wavevector and w is the size of the circular pupil- same notation as in class; then use superposition.)