ECE 162C: PROBLEM SET #6

DUE MONDAY, June 2, 2008

Design a Vertical Cavity Surface Emitting Laser (VCSEL) for operation at 1.5 μm and room temperature.

1. Determine the composition x and y of the active region $In_xGa_{1-x}As_yP_{1-y}$ so the bandgap corresponds to 1.55 μm and the lattice parameter matches InP. What is the bandgap and lattice parameter?
2. For the mirror, use a stack of InP and InGaAsP (bandgap =1.3 μm) quarter wave thick layers. What is the index at 1.5 μm of InP and InGaAsP(bandgap =1.3 μm)? Calculate how many periods are necessary to achieve 99% reflectivity.
3. Assume all the layers have a loss of 10 cm^{-1}. Assume the overlap of the mode and the active region is 1. Assume reasonable values for the gain of a quantum well layer. How many quantum wells are needed? What is the threshold gain?
4. Neglect scattering loss and assume an area of 10 μm^2. What is the threshold current density and the threshold current? What is the differential quantum efficiency?
5. What is the relaxation oscillation frequency when the laser is biased at twice threshold? How much power does it emit at twice threshold?

You will need to make a number of assumptions and look up values to complete the problem. State your assumptions and assumed values clearly.