

**ECE 162C: PROBLEM SET #4  
DUE FRIDAY, MAY 2, 2004, 4 pm**

**(No late submissions because the solution will be emailed out).**

**PROBLEM:**

Consider a 1.3  $\mu\text{m}$  buried heterostructure InGaAsP /InP bulk laser 400  $\mu\text{m}$  in length with confinement factor  $\Gamma=.2$ , internal quantum efficiency of 80% and internal loss of  $10 \text{ cm}^{-1}$ , cleaved facets, 0.2  $\mu\text{m}$  thick active region, 2  $\mu\text{m}$  wide waveguide, 1ns lifetime, linear gain dependence on carrier density with a differential gain  $2 \times 10^{16} \text{ cm}^2$  and transparency carrier density of  $1 \times 10^{18} \text{ cm}^{-3}$ . Assume the index of the active region is 3.5 and the index of the InP cladding is 3.17, and the group index is 3.6. Assume the mirror reflectivity is 0.3.

1. Draw the transverse conduction band and valence band diagrams under zero bias and forward bias.
2. Sketch the electron and hole carrier densities under zero and forward bias.
3. Plot the peak gain versus carrier density.
4. What is the mirror loss?
5. What is the threshold modal gain?
6. What is the threshold current?
7. What is the differential quantum efficiency?
8. What is the axial mode spacing?
9. Calculate the width for a single transverse mode. Is the laser single transverse mode?
10. Calculate the width for a single lateral mode. Is the laser single lateral mode? (Use the effective index method).