ECE 162C: PROBLEM SET #5

DUE FRIDAY, MAY 16, 2004, 4 pm

1. Consider a semiconductor laser operating at 1300 nm with a InGaAsP laser cavity of length 200 micron with cleaved facets. Calculate the cavity mode nearest to the operating wavelength, the separation of the modes and the spectral width of the mode. Use n(GaAs) = 3.6.
   [Hint: Refer to sec 1.7]

2. Consider a double heterostructure InGaAsP laser operating at 1310 nm. The cavity length L = 60 micron, width W = 10 micron and d=0.25 micron. The refractive index is 3.5. The internal loss coefficient is 10 cm^{-1}.
   a. Find the threshold material gain.
   b. If the threshold current density is Jth = 500 A / cm^2 and carrier lifetime is 10 ps, find the threshold electron concentration.
   c. Calculate the lasing optical power and intensity when the current is 5 mA.
   Assume internal quantum efficiency of 0.8.

3. Consider a **DFB laser** operating at 1550 nm. Suppose that the refractive index n = 3.4 (InGaAsP). What should be the corrugation period for a first order and second order gratings? How many corrugations are needed if the cavity length is 20 micron for both first and second order gratings? Which is easier to fabricate?

4. A 250 micron – long InGaAsP laser with cleaved facets has an internal loss of 40 cm^{-1}. It operates in a single mode with the modal index 3.3 and the group index 3.4. Assume internal quantum efficiency of 90 %.
   a. Calculate the photon lifetime.
   b. What is the threshold value of the electron population? Assume that the gain varies linearly with dg/dN = $6000s^{-1}$ and Ntr = 10^8.
   c. Find the threshold current by using 2 ns as the carrier lifetime.
   d. How much power is emitted from one facet when the laser is operated twice above threshold?
   e. Calculate the resonance frequency of the relaxation oscillations while operating twice above threshold. Use a confinement factor of 0.2 and cross section of the active region is 0.4 μm^2