November 16, 2021

Homework 11
OPTI 507
(due November 23, 2021)

Problem 1:
Consider an interface in a quantum well system where the mass is z-dependent (i.e. it is different in adjacent layers and thus different on either side of the interface). Assuming that $\zeta(z)$ is continuous at the interface, show that $(1/m(z))d\zeta(z)/dz$ is continuous at the interface.

(10 points)

Problem 2:
Assume you have grown a GaAs/$Al_xGa_{1-x}As$ quantum well with a mole fraction of $x = 0.23$ and thickness $L_z = 118$Å. Determine the number of bound electron states, or, more precisely, the number of conduction band subbands with envelope functions localized in the well.

Instructions:
Use the following interpolation formulas:

$$\begin{aligned} m_e &= (0.0665 + 0.0835x)m_0 \\ E_g &= (1.424 + 1.247x)eV \end{aligned}$$

to determine the well and barrier parameters (m_0 is the electron mass in vacuum). The conduction band offset is $\Delta E_c = 0.66\Delta E_g$.

(10 points)

Problem 3:
Continuing Problem 2, and assuming, for simplicity, that the holes experience the same quantum confinement shift as the electrons, determine approximately the quantum well band gap (smallest interband transition energy). State your result in terms of energy eV, frequency Hz, wavenumber cm^{-1}, and wavelength (in vacuum) μm.

(10 points)