Problem 1

For the 1-D GaAs/AlGaAs superlattice, the effective mass for InGaAs and InAlAs are denoted as $m_1$ and $m_2$, respectively.

(a) Find the general solution of the Schrödinger equation in regions I and II.

(b) Write the boundary conditions that allow us to solve the coefficients and the eigenvalue (energy) $E$. Note that in this case, the effective mass of electron in InGaAs and InAlAs is different.

(c) Draw a typical wavefunction across the superlattice based on your answer in (b).

(d) Can $E$ be greater than $V_o$? If your answer is yes, draw a typical wavefunction with $E > V_o$. If your answer is no, give your explanation.

![Superlattice Diagram]

Problem 2

Problem: For an npn BJT, describe what happens to the collector current, the base current, and the current gain under each of the following scenarios:

(a) Double the emitter doping (everything else unchanged).

(b) Reduce the base width to half (everything else unchanged).

(c) Increase the emitter-base junction forward bias by 0.1 V (everything else unchanged).

(d) Replace the Si base with a uniform SiGe base of bandgap 0.1 eV smaller than that of Si (everything else unchanged).