Solving plan

1. Normalizing a given electromagnetic mode. When assuming a lossless cavity, the mode field is expressed through

where are normalized so that. A potential complication here is that variesin space according to the COMSOL mesh.

1. Calculating the effective dipole of the transition. Here, we will take the two relevant wavefunctions, and calculate the dipole moment as:

(notice that the dipole is only in the z direction because this is a subband transition between two conduction levels).

1. Calculating the emission rate to the mode in each point in space to each mode using the dipole approximation,

Where is the interaction Hamiltonian, and is the z component of .

Extensions:

1. Include the Q factor of the mode and calculate the rate for far-field emission, the rate for cavity mode emission, and the rate for direct emission into heat.
2. If there is not a perfect resonance between the dipole’s energy and the mode, Extend the delta function of the mode energy to a Lorenzian, given the mode’s losses.
3. To analyze the structure as a whole, assume a (normalized) dipole distribution so that we can calculate the effective emission rate of the structure as a whole **.**
4. Understand weather the electronic wavefunctions are large enough to go beyond the dipole approximation. For this, you should change the Hamiltonian to a one.
5. Understand if there is a field variation between the layers which must have a correction to the modes.