Tutorial Sheet – Lecture 14

Optical Transitions

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1) Describe, in your own words, using schematic diagrams as necessary;
   a. Absorption
   b. Spontaneous emission
   c. Stimulated emission

2) Define the rates of the transitions above and describe how a change in carrier density can result in optical gain. Define the terms "inversion" and "transparency" in a real material used within a laser.

3) Derive the electronic density of states in three dimensions.

4) At room temperature, a direct band-gap semiconductor has a band-gap of 1.42 eV, and an absorption coefficient of 4×10^6 m^{-1} at 750nm. Stating all assumptions;
   a. Calculate the thickness of semiconductor required to absorb one half of the incident photons at 750nm.
   b. Estimate the absorption coefficient at 650nm
   c. Comment on the effect of increasing temperature on the absorption coefficient at 750nm.
   d. Estimate the effect on the absorption coefficient of replacing the sample with a semiconductor with an effective mass half that of the original.