Exercise 9.2-1

Quick Questions to

9.2 - Optoelectronics - Important Principles and Technologies

- Here are some quick questions
  - Describe some measures necessary of you want to produce a high-efficiency **LED**. Use hand drawings to illustrate (at least) three major points.
  - How can you best define a recombination volume?
  - Draw the band diagram of an **Np** junction in equilibrium with the bandgap of the **N**-type semiconductor about twice the size of the **p**-type material. Discuss choice you make if necessary.
  - Discuss advantages an problems of hetero junctions for light emitting devices
  - Describe the working principle of **MBE** and what it means in terms of realization.
  - Describe the mechanisms of *fundamental absorption* (**FA**) and *stimulated emission* (**SE**) with the aid of a band diagram. What kind of relation between the rates R_{Se} and R_{FA}, i.e. the number of events per second (and **cm^2**) must you have if amplification of light is to take place?
  - What is the meaning of "inversion" in the context of a semiconductor Laser?
  - What is "pumping" in the context of a Laser and why is a semiconductor very well suited for efficient "pumping"?
  - How can you turn a light amplifier into a Laser? What does it mean technically for processing your semiconductor?

- Here is a somewhat "longer" question:
- The picture shows a schematic "to scale" drawing of a simple blue Laser diode and the relevant material parameters in the "master" diagram.
  - What kind of approximate band gap energy can you assign to the various layers? Draw a schematic band diagram of this kind of situation.
  - Which layer is the light-producing one?
  - What is the function of the three relatively thin layers in the center region?
  - What could be the function of the two thicker pure **GaN** layers?
  - Why is the whole structure on an **Al_2O_3** substrate (= sapphire) and what is the *electrical* problem encountered?
  - What might be the problem necessitating a "buffer" layer between the **Al_2O_3** substrate and the stack of functional layers?
  - Where are the mirrors necessary for a Laser?
  - What is obviously used for **n**- or **p**-doping? Make a guess as to why the very thin central layer contains **Mg** *and* **Si** as dopants