ELEC-3140 Semiconductor physics **Full exam, Dec 12, 2018**

Write your name, student number, degree programme (*e.g.*, EleNano), course code, and date of the exam on each of the answer papers.

Also write "FULL EXAM" in the "further information" field.

1. Explain briefly and exactly (with a couple of sentences):
   a) Wigner-Seitz cell,
   b) pseudomorphic,
   c) biaxial strain,
   d) bound exciton,
   e) excess carrier concentration, and
   f) continuity equation.

2. a) Describe how to determine the Miller indices for a crystal plane and for a crystal surface in a cubic crystal. b) Describe shortly what methods or phenomena can be used to engineer the value of the semiconductor band gap energy and other band properties.

3. Draw a schematic absorption spectrum of a semiconductor (*i.e.*, α as a function of λ). Illustrate the different areas of the spectrum and describe the corresponding absorption process. Try to include at least five different absorption processes.

4. A hypothetical semiconductor has a density of states function approximated by
$$N(E) \propto C \cdot \sqrt{E - E_C}^{3/2},$$
where C is an arbitrary constant. Calculate the energy at which the electron occupation has its maximum in a non-degerate (not highly doped) semiconductor crystal. You can use the Maxwell-Boltzmann distribution.

5. For intrinsic semiconductor the relaxation times for phonon scattering and ionised impurity scattering at $T = 300$ K are $\tau_L = 1.1\,ps$ and $\tau_I = 1.9\,ps$, respectively. The effective mass of the carriers is $0.10\,m_0$. The temperature dependences of the scattering processes are
$$\tau_L \propto T^{-\frac{3}{2}} \quad \wedge \quad \tau_I \propto T^{\frac{3}{2}}.$$
Other scattering processes can be ignored. a) At what temperature is the mobility largest? b) What is the value of the largest mobility?

Constants and material parameters on the other side! (The quality of the print is not the best, so no points will be lost based on these numbers.)