**ELEC-3140 Semiconductor physics** **Mid-term exam 2, 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.

1. Explain briefly (with a couple of sentences):
   a) Hall effect,
   b) Einstein relation,
   c) Shockely-Read-Hall recombination,
   d) bound exciton,
   e) excess carrier concentration,
   f) continuity equation.

2. a) Describe the two main scattering mechanisms of charge carriers moving in a semiconductor. Additionally, give at least one example of other scattering mechanisms. b) Describe the formation of depletion region in a pn-junction. List also the assumptions made in the abrupt depletion region approximation.

3. Draw a schematic absorption spectrum of a semiconductor (i.e. $\alpha$ as a function of $\lambda$). Describe the different areas of the spectrum each with an appropriate absorption process. Try to include at least five different absorption processes.

4. 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?

5. A piece of semiconductor is illuminated continuously so that generation $G_L$ is constant throughout the piece. If there is surface recombination rate of $S$ at one end of the piece, what is the hole concentration as a function of position (away from that surface) at the steady state?

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.)