ELEC-3140 Semiconductor physics **Mid-term exam 1, Oct 24, 2018**

Write your name, student number, degree programme, course code, and date of the exam on each of the answer papers.

1. Explain briefly, but exactly (with a couple of sentences):
   a) diamond lattice structure,
   b) Bravais lattice,
   c) heterojunction,
   d) deformation potential,
   e) quantum wire,
   f) molecular beam epitaxy.

2. a) Describe the division of crystal defects by their dimensionality. Give examples of crystal defects in each category. b) Describe the quantum structures by dimensionality. Also sketch the density of states (DOS) function for each one of them along with the bulk DOS. Place all the DOS functions in the same graph and be careful where you start each of the curves on the energy scale.

3. Draw and describe the four band model for semiconductor band structure. What are the four bands, what are their functional shapes and how the curvature of the band has an effect on the semiconductor parameters? If the semiconductor has an indirect band gap, what changes in this model?

4. a) Pseudomorphic $Ga_{0.25}In_{0.75}As_{0.5}P_{0.5}$ layer has been grown epitaxially on an InP (100) substrate. Calculate the relative lattice mismatch of the layer on the InP substrate. b) Calculate the vertical component of the lattice constant of the layer material on the substrate. c) Pseudomorphic $Ga_{0.50}In_{0.50}P$ layer has been grown epitaxially on a GaAs (100) substrate. Calculate the energy band gap of the layer material (no need to take strain effects into account) and use that to find the emission wavelength of the compound. The bowing parameter of GaInP is 0.79.

5. Calculate the energy at which the electron distribution of a parabolic conduction band has its maximum in a 3-dimensional non-degenerate (not highly doped) semiconductor crystal. Use the Maxwell-Boltzmann distribution.

Constants and material parameters on the other side! (The quality of the print is not the best, but bear with it.)