FYS3410, Spring 2017, final examination

The examination is oral and with external censorship. You will draw a question among those questions given in advance, and you will then have 30 minutes preparation time. The examination itself will take approximately 30 minutes. During the first 15 minutes of the examination you present your answer to the question which you have drawn; in the next 10-12 minutes you will be asked additional questions related to the content of the course; the rest of the time is for internal discussion of your performance. Altogether your presence is required for approximately 1 hour.

Note that 15 minutes is not a lot of time for making a presentation - you will have to be selective and you will also be evaluated on how well you have selected relevant materials. You can use any sort of notes during the presentation, for instance to copy a complex equation you need in the analysis. However, please consider not to excaudate this possibility, since too excessive use of notes may be used against you.

The examination takes place at the Kristen Nygaards Hus at room 3212.

Examination questions

1. **Periodic lattices** as a result of the interatomic force balance in solids: basic ideas and specific interpretation of the ionic bonding, e.g. in NaCl.
2. **Defects in crystals**; reasons to occur; equilibrium concentration as a function of temperature and strain for vacancies; examples of properties governed/affected by defects.
3. **Wave diffraction in crystals**; Laue condition; Bragg planes; Brillouin zones (BZ) – introduce with x-rays and shortly generalize to other relevant waves.
4. **Atomic vibrations in infinite periodic lattices**; dispersion relation - $\omega(k)$ and group velocity - $v_g(k)$ in the 1st BZ of 1D crystal; acoustic and optical branches of $\omega(k)$.
5. **Quantization of atomic vibrations** = restrictions on k-numbers as a result of boundary conditions; phonon density of states (DOS) as a function of k and ω for 1D, 2D, and 3D.
6. **Lattice heat capacity**; analysis of different models; implications of the system dimensionality.
7. **Lattice thermal conductivity**; analysis at "low" and "high" temperatures; implications of the system dimensionality.
8. **Free electron gas (FEG)** or Drude model for electrons in solids - success and limitations.
9. **Free electron Fermi gas** (FEFG); energy dispersion E(k); DOS in the ground state in 3D.
10. **FEFG DOS in quantum wells and quantum wires** in the ground state.
11. **FEFG at T>0**; heat capacity of FEFG; chemical potential (μ) versus Fermi energy (ε_F).
12. **Transport properties of FEFG** applying thermal, electric, and magnetic fields;
13. **Origin of the energy band structure** in periodic lattices; "molecular orbital" and "electron wave diffraction" reasoning; electrons in a periodic potential.
14. **Filling energy bands with electrons**; k_F vs k_{BZ} in typical metals, e.g. Na; Fermi sphere; metal vs insulators; reasons for band overlaps;
15. **Effective mass approximation** and its application for understanding "hydrogen-like" impurities in semiconductors
16. **Electrons and holes in semiconductors**; intrinsic and extrinsic carriers; variations in μ.
17. **p-n junctions**; balance between diffusion and drift currents for electrons and holes; application of the forward or reverse external bias;

Schedule for the final oral examination in FYS3410, spring 2017

01/06/2017 — 01/06/2017

08.30-09.00	
09.00-09:30	

09.00-09.30	Erik
09.30-10.00	

09.30-10.00	Vilde
10.00-10.30	

10.00-10.30	Børge
10.30-11.00	

10.30-11.00	Anisa
11.00-11.30	

11.00-11.30	Fredrik
11.30-12.00	

11.30-12.00	Magnus
12.00-12.30	

break

12.30-13.00	Thomas
13.00-13.30	

13.00-13.30	Arnoldas
13.30-14.00	

13.30-14.00	Sagal
14.00-14.30	

14.00-14.30	Andreas
14.30-15.00	

14.30-15.00	Furkan
15.00-15.30	

15.00-15.30	
15.30-16.00	

02/06/2017 — 02/06/2017

08.30-09.00	
09.00-09:30	

09.00-09.30	Dagfinn
09.30-10.00	

09.30-10.00	Kjetil
10.00-10.30	

10.00-10.30	Sebastian
10.30-11.00	

10.30-11.00	Luca
11.00-11.30	

11.00-11.30	Giacomo
11.30-12.00	

11.30-12.00	Alberto
12.00-12.30	

break

12.30-13.00	Mathias
13.00-13.30	

13.00-13.30	Kjell-Erik
13.30-14.00	

13.30-14.00	Joachim
14.00-14.30	

14.00-14.30	Maria
14.30-15.00	

14.30-15.00	Hvaldor
15.00-15.30	

15.00-15.30	Elena
15.30-16.00	