1. **Accumulate 100 points (out of 120) by answering the questions.**

2. **If you submit more than 100 points, the grade will be calculated as a ration between “applied” and “earned”.**

Submission deadline: 10/07/2021

1

Q1(20 points)

Surface tension of ice at -21 °C is about 0.25 N/m. At this temperature, ice melts under 2,000 atm (1 atm=101.3 kPa) pressure. What is the smallest particle of ice that can exist at -21 °C?

Q2 (20 points)

What should be the concentration of free electrons in a material to keep it transparent for green light (600 nm wavelength)? No other absorption mechanisms are in place and the electron relaxation time is very large.

Q3 (20 points)

From ET and EL for NaI and NaCl given in the lecture notes calculate

1) Ionic plasma frequency.

2) Effective charge of ions in the lattice, assuming that the refractive index at the infrared range is close to that in visible.

3) Optical phonon frequency. Estimate the stiffness of the bonds and the speed of sound.

Q4 (20 points)

A thin films of SiO_2 (dielectric constant ~4) in a field effect transistor has a thickness of 10 nm and it is subjected to a difference of electrical potential of 5 V. What is the average electric field that acts on each atom?

Q5 (20 points)

A monatomic crystal contains 5×10^{22} atoms per cm^3. The static dielectric constant of the crystal is 5. What is the polarizability of the atoms in the crystal? What should be the polarizability of the atoms to have the dielectric constant infinitely large?

Q6 (20 points)

Using the ionic polarizability of ions given in the lecture notes and density tables, calculate the expected dielectric constant for MgO, LiF and CeO_2.