Try to answer shortly by listing the essential arguments (phenomena, materials properties, other quantities, relations, ...). Figures are also a good way to explain dependencies. The exact forms of different equations are not important, but the quantities and their relations needed to describe a phenomenon or property.

1. *Charge carrier density in homogeneous intrinsic or doped semiconductors.*

   (a) Which are the approximations and quantities used to describe electron and hole densities in intrinsic semiconductors? Why? (2 p)

   (b) How do the charge carrier densities and the chemical potential behave in an intrinsic semiconductor as a function of the temperature? What is the magnitude of typical densities at room temperature? (2 p)

   (c) How is the model for intrinsic semiconductors generalized to doped semiconductors? (1 p)

   (d) Consider a semiconductor doped by donor impurities. What is the magnitude of the impurity concentration in typical doping? How do the charge carrier densities and the chemical potential behave as a function of the temperature? (2 p)

2. *Conductivity of doped semiconductors.*

   (a) How does the conductivity behave as a function of temperature? What are the temperature dependent quantities and processes affecting the conductivity? (2 p)

   (b) How does the magnitude of the electric field affect on the electron mobility in elemental and compound semiconductors? What are the field dependent processes affecting the mobility? (2 p)

3. *pn junction.*

   (a) Which principles (Starting point of the Schottky model and the approximations made in it) and materials parameters determine the voltage step and the width of the depletion zone in equilibrium? (2 p)

   (b) Which are the currents flowing in equilibrium? (1 p)

   (c) How is the equilibrium model generalized to the case of an external bias voltage over the junction? What is the meaning of quasi-Fermi levels? (2 p)

   (d) Which are the current components flowing and the form of the total current? Which are the materials parameters determining the current? (2 p)

4. *Response of materials to an external magnetic field*

   (a) Describe the response of open shell atoms to the external magnetic field $\mathbf{B_0}$ in terms of magnetic moments, quantized energy levels, and their filling at a finite temperature. How the resulting susceptibility depends on temperature (4 p)