Problem 1: Reciprocal lattice (4 points):

a) Show that the reciprocal lattice of a primitive hexagonal Bravais lattice is also primitive hexagonal. Under which condition is the ratio $c/a$ equal in both lattices?

b) Show that the reciprocal lattice of a face-centred cubic lattice (fcc) is a body-centred cubic lattice (bcc).

Problem 2: Bragg equation (4 points):

Show that the Bragg equation can be derived from the equation $\Delta \vec{K} = \vec{K}$ by using the relation

$$d(hkl) = \frac{2\pi}{|\vec{K}|},$$

with $d(hkl)$ as the distance between two neighbouring lattice plains.

Problem 3: Structure factors (4 points):

Calculate the lattice structure factors determined by the base atoms of the following non-primitive unit cells:

a) face-centred (fcc)
b) Zincblende (ZnS)
c) Rocksalt (NaCl)

Problem 4: Monoclinic lattice (4 points):

Given is a monoclinic lattice defined by the lattice vectors $\mathbf{a}_1 = (2,-1,0)$, $\mathbf{a}_2 = (0,1,0)$, and $\mathbf{a}_3 = (0,0,1)$.

a) Calculate the reciprocal lattice vectors $\mathbf{b}_1$, $\mathbf{b}_2$, and $\mathbf{b}_3$.

b) Calculate the angle between $\mathbf{a}_1$ and $\mathbf{b}_1$.

c) A set of parallel lattice planes be defined by the Miller indices $h = 2$, $k = 2$, and $l = 0$.

Calculate the distance between two of these plains using the reciprocal lattice vectors $\mathbf{b}_1$, $\mathbf{b}_2$, and $\mathbf{b}_3$. 