Exercises 10, 29.04.2025

10.1. The sample, a thin bar, can be cut from a conductive material in an arbitrary direction with respect to the symmetry axis of the material (Fig.1).
The symmetry point group of the material is $\bar{3}$
The voltage is applied between the top and bottom surfaces of the bar, causing an electric current to flow. The sample is kept mechanically free at a constant temperature

In what direction should the bar be cut in order to prevent the appearance of a transverse voltage in the described system? Find **all possible orientations** of such bar.

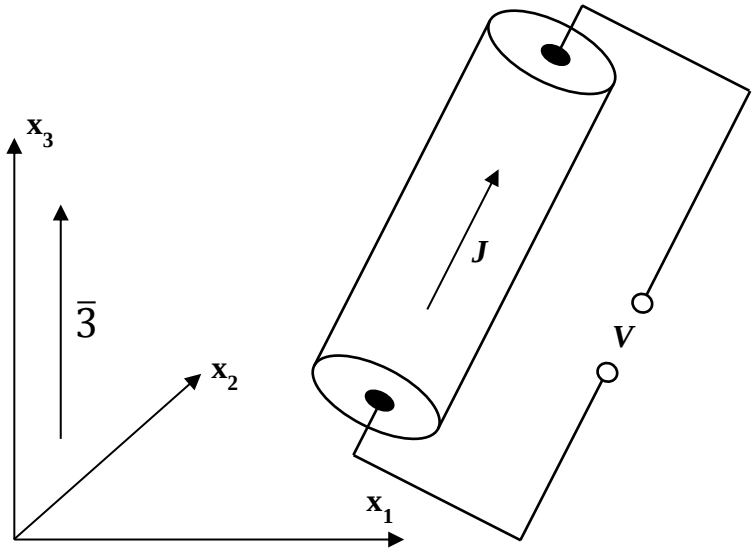

Fig.1.

10.2 For this exercise use the following table for $BaTiO_3$ in $4mm$ phase (the 4-fold symmetry axis is directed along x_3)

s_{11}	8.05×10^{-12} m^2/N	d_{15}	392×10^{-12} C/N
s_{12}	-2.35×10^{-12} m^2/N	d_{31}	-35×10^{-12} C/N
s_{13}	-5.24×10^{-12} m^2/N	d_{33}	86×10^{-12} C/N
s_{33}	15.7×10^{-12} m^2/N	K_{33}	150
C	$2.42 \times 10^6\ J/(m^3 \cdot K)$	p_3	-5 $\times 10^{-4}\ C/(m^2 \cdot K)$
α_3	$3.5 \times 10^{-5}\ 1/K$		

The impact of mechanical conditions on the heat capacity is investigated. The parallelepiped $BaTiO_3$ sample in its tetragonal phase $4mm$ (4-fold symmetry axis is directed along the x_3 axis) is used for heat capacity measurements. The sample faces are directed along (100), (010), and (001) crystallographic directions. The faces (001) are covered with electrodes and short-circuited, the external electric field is always absent.

In measurement **(a)**, the sample is kept mechanically free.

In measurement **(b)**, the sample is kept mechanically free in x_1 and x_2 directions, while the motion in x_3 direction is blocked.

Find the relative difference between heat capacities obtained in the measurements **(a)** and **(b)** $\frac{C_{(b)}-C_{(a)}}{C_{(a)}}$ Based on your calculations, is the impact of mechanical conditions on the heat capacity small enough to be neglected?

10.3. Using the equation of state of ferroelectric (Lecture 8) derive the formula for the coercive filed expressed as a function of ***α*** and ***Ps*** (spontaneous polarization)