1. A set of Cartesian axes $x_i$ is transformed to a new set $x_i'$ by a clockwise rotation of $\theta$ about the $x_2$ axis:
   (a) Sketch the position of the new coordinate system relative to the original system.
   (b) Label the angles corresponding to the inverse cosines of $c_{11}$, $c_{13}$, $c_{31}$, $c_{23}$ and $c_{32}$.
   (c) Evaluate the direction cosine array $c_{ij}$ by determining cosines of the appropriate angles.

2. For each of the following operations, write the equations specifying the new axes $x_i'$ in terms of the original axes $x_i$. Establish the direction cosine scheme by extracting the appropriate coefficients from these equations.
   (a) reflection in the $x_2x_3$ plane
   (b) a $120^\circ$ rotation about the [111] axis of a cubic crystal
   (c) a 2-fold rotation about [110] in a cubic crystal

3. Aragonite is an orthorhombic form of CaCO$_3$, point group 2/m 2/m 2/m, with lattice constants $a = 4.94$, $b = 7.94$, $c = 5.72$ Å. Measured relative to the crystallographic axes, the dielectric susceptibility* is given by
   $$ k_{ij} = \varepsilon_0 \begin{bmatrix} 8.8 & 0 & 0 \\ 0 & 6.7 & 0 \\ 0 & 0 & 5.6 \end{bmatrix} $$
   where $\varepsilon_0$, the permittivity of space, is $8.85 \times 10^{-12}$ coulombs/volt-meter. Suppose a (101) plate is cut from the crystal. What is the form of the susceptibility tensor referred to axes taken relative to the plate?

*The dielectric susceptibility relates polarization, $P$ (dipole moment per unit volume) to an applied electric field: $P_i = k_{ij} E_j$