Preliminary Examination – Structures
Sample question in Solid Mechanics

In a cartesian coordinate system let \( x_i \) denote the position of a particle in the undeformed body, and let \( \xi_i \) denote the position of this particle in the deformed body, where \( x_i \) and \( \xi_i \) are measured along the same coordinate axes. The deformation is homogeneous and is given by

\[
\begin{bmatrix}
\xi_1 \\
\xi_2 \\
\xi_3 \\
\end{bmatrix} =
\begin{bmatrix}
1 & -3/4 & 0 \\
0 & 1 & 0 \\
0 & 0 & 1 \\
\end{bmatrix}
\begin{bmatrix}
x_1 \\
x_2 \\
x_3 \\
\end{bmatrix}
\]

(a) Determine the slopes, \((dx_2)/(dx_1)\), of line elements PQ and PR in the \( x_1 - x_2 \) plane of the undeformed body that map into orthogonal line elements P*Q* and P*R*, respectively in the deformed body.

(b) Determine the rigid body angle of rotation of the body about the \( x_3 \)-direction by computing the principal strain directions in the undeformed body, and the map of these directions in the deformed body.