Department of Mechanical Engineering

Michigan State University

Intermediate Solid Mechanics
Ph.D. Qualifying Examination

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You may use only one reference book.

All Questions are weighted equally

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Network Devises Are Not Allowed
All Work Should Be Shown For Full Credit
1) Consider a long, thin steel plate of thickness \( t \), width \( 2h \) and length \( 2a \). The plate is subjected to loads that produce the uniform stresses \( \sigma_0 \) at the ends and a temperature change \( T_1 \). The edges at \( y = \pm h \) are placed between the two rigid walls. Show that, by using an inverse method the displacements are expressed by:

\[
\begin{align*}
    u &= \left[ -\frac{1}{E} \left( 1 - \nu^2 \right) \sigma_0 + (1 + \nu) \alpha T_1 \right] x; \quad \nu = 0 \\
    w &= \left[ \frac{1}{E} \left( 1 + \nu \right) \sigma_0 + (1 + \nu) \alpha T_1 \right] z
\end{align*}
\]

Hint: Assume that \( \sigma_x = -\sigma_0 \).
2) A 3-m by 1-m by 2-m parallelepiped is deformed by movement of corner $A$ to $A'$ (2.9995, 1.0003, 1.9994), as shown in the figure. Using the displacement field given below, calculate (a) the strain components $\varepsilon_x$, $\varepsilon_z$, and $\gamma_{xz}$ at point $A$ and (b) the normal strain ($\varepsilon_{x'}$) in the direction of line $BA$ ($x'$-axis lies along a line from $B$ to $A$). (20)

\[ u = c_{1xyz} \quad v = c_{2xyz} \quad w = c_{3xyz} \]
3). These stresses are acting on the cube: \( \sigma_x = 5\text{MPa} \), \( \sigma_y = 10\text{MPa} \), \( \tau_{xy} = -6\text{MPa} \), \( \sigma_z = -4\text{MPa} \). (a) Indicate the stress components on the cube. (b) Determine the principal stresses and maximum shear stress.
4). A beam with cross section as shown is subjected to a bending moment $M_y = 100 \times 10^3$ lb-in passing through its centroid. Determine the maximum stress on the section.