

HOME ASSIGNMENT #1**Warm-Up Exercises**

Write out the following tensor equations in full:

(**Note:** these equations do not necessarily have any real meaning)

$$1. \mathbf{G}_i = \ell_{\alpha\beta} \mathbf{M}_{\alpha\beta} \mathbf{n}_i$$

$$2. \mathbf{A}_{ij} = \mathbf{Q}_{ijkl} \tau_k \mathbf{x}_l \quad (\text{for } i = 2, j = 3)$$

$$3. \mathbf{a}_{mn} \frac{\partial \mathbf{u}_n}{\partial t} + \mathbf{f}_m = 0$$

$$4. \mathbf{E} = \frac{1}{2} \sigma_{\alpha\beta} \varepsilon_{\alpha\beta}$$

$$5. \sigma_{23} = \ell_{2\tilde{m}} \ell_{3\tilde{n}} \sigma_{\tilde{m}\tilde{n}}$$

Practice Problems

6. Write out the succinct tensor equation that describes the following notation:

$$\begin{Bmatrix} H_1 \\ H_2 \\ H_3 \end{Bmatrix} = \begin{bmatrix} C_{111} & C_{122} & 2C_{112} \\ C_{211} & C_{222} & 2C_{212} \\ C_{311} & C_{322} & 2C_{312} \end{bmatrix} \begin{Bmatrix} M_{11} \\ M_{22} \\ M_{12} \end{Bmatrix}$$

Note any assumptions that you had to make (if any).

7. The following is the tensorial form of the strain compatibility equations:

$$\frac{\partial^2 \varepsilon_{nk}}{\partial y_m \partial y_l} + \frac{\partial^2 \varepsilon_{ml}}{\partial y_n \partial y_k} - \frac{\partial^2 \varepsilon_{nl}}{\partial y_m \partial y_k} - \frac{\partial^2 \varepsilon_{mk}}{\partial y_n \partial y_l} = 0$$

Write one useful equation represented by this generic form. Convert this equation to engineering notation as well.

Application Tasks

8. An aerobatic airplane has a key structural part of the empennage designed to undergo a design limit load of 7550 N at the operational maximum g-capability of the aircraft of 4.2 g. This part is made of a material with a yield stress of 250 MPa and an ultimate stress of 350 MPa. The static tests on this part made at the factory showed an ultimate margin of safety of 18.2% on this part.

During training exercises, a g-meter shows that the pilot pulled a maneuver of 4.6 g. Upon review of the information from this exercise, the maintenance chief of the company that owns the plane needs to determine whether the plane can continue to be safely flown. Give your answer/thoughts in this regard with appropriate calculations as evidence.