UNIVERSITY OF TURKISH AERONAUTICAL ASSOCIATION
AERONAUTICS and ASTRONAUTICS

University of Turkish Aeronautical Association
Aeronautics and Astronautics
AEE 361-Applied Elasticity
Midterm Examination – 25.11.2020, 06:40 p.m.
Time allowed: 110 min.

- **This is an open notes examination.**
- **You can use calculators without programming and graphical capabilities.**
- **Your solution must be neat and consistent, and must include all intermediate steps even if you think it is obvious.**

Student ID:
Name & Surname: *Signature*

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1. (10 *points*) Simplify (expand) the following expressions. δ is Kronecker delta. In your final answer no letter indices must appear. (parts (a) and (b): each 3 *points*, part (c): 4 *points*)

(a) $\delta_{kl}\delta_{lk}$

(b) $\delta_{jj}\delta_{kk}$

(c) $a_k b_m \delta_{ii}\delta_{km}$

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2. (35 *points*) The state of stress at a point in a loaded solid is given as

$$[\sigma] = \begin{bmatrix} 5 & 0 & 2 \\ 0 & 0 & 0 \\ 2 & 0 & -5 \end{bmatrix} \text{MPa}$$

(a) Calculate the principal stresses
(b) Plot the Mohr's circles for this point and calculate the maximum shear stress
(c) Determine the principal directions only for the largest principal stress.

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3. (30 *points*) The tensorial strain at a particular point in a loaded medium is found to be as follows:

$$[\varepsilon] = \begin{bmatrix} 1 & -2 & 0 \\ -2 & 6 & 0 \\ 0 & 0 & 1 \end{bmatrix} \times 10^{-4}$$

(a) Calculate the normal strain at this point in the direction of the vector $\vec{A} = \vec{e_1} + 2\vec{e_2} - 2\vec{e_3}$ (Hint: The direction cosines in this direction are the components of unit vector along vector $\vec{A}$)

(b) Considering a CCW rotation of 90º about the x_2 - axis, construct the transformation matrix.

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4. (25 *points*) A displacement field in a body is given by

$$u = c\left(x^2 + 10\right)$$
$$v = 2cyz$$
$$w = c\left(-xy + z^2\right)$$

where $c = 10^{-4}$. Determine the state of strain and stress on an element positioned at (0, 2, 1). Use E = 70 GPa and ν = 0.3.