



**Interdepartmental Program of Postgraduate Studies in "Applied Mechanics"**  
**Erasmus Mundus Joint Master Program "STRAINS" in "Advanced Solid Mechanics"**  
**Final examination in "Biomechanics of Soft Tissues"**  
**Instructor: Assistant Professor D. Eftaxiopoulos**  
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**Question 1 (5)**

The fourth "invariant"  $I_4$  of the right Cauchy - Green deformation tensor  $\mathbf{C}$ , that is used in the mechanical modeling of the cornea, is given via the relation

$$I_4 = \mathbf{C} : \mathbf{M} \quad (1)$$

where  $\mathbf{M}$  is the structure tensor of the fibers, in the undeformed configuration. Show that

$$I_4 = |\mathbf{F} \cdot \mathbf{m}|^2 \quad (2)$$

where  $\mathbf{F}$  is the deformation gradient tensor and  $\mathbf{m}$  is the unit directional vector of a single fiber in the undeformed configuration.

**Question 2 (3)**

The isotropic part of the strain energy density function for the annulus fibrosus, per unit volume in the undeformed configuration, is given via the relation

$$\underline{W}^{iso} = (I_3 - I_3^{-1})^2 + (I_1 I_3^{-1/3} - 3)^2. \quad (3)$$

Calculate the respective 2<sup>nd</sup> Piola - Kirchhoff stress tensor  $\underline{\tau}$ .

**Question 3 (2)**

Degradation of the polyester scaffold that is used for cartilage synthesis, is described by the differential equation

$$\frac{dm_{sc}(t)}{dt} + \frac{1}{\tau_{sc}} m_{sc}(t) = 0 \quad (4)$$

where  $m_{sc}(t)$  is the unknown remaining mass of the scaffold after the passage of time  $t$  and  $\tau_{sc}$  is a given characteristic time of degradation. Calculate the remaining scaffold mass  $m_{sc}(t)$ , if the initial mass of the scaffold  $m_{sc}(0)$  at time  $t = 0$ , is known.