Université Mohamed - KHIDER - BISKRA
Département de Génie Mécanique – MMC / Master – 2026/2027
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Travaux Dirigés (Serie N° 3)

Exercise N° 1 :

The motion of a continuous medium is defined in an orthonormal frame R=(O,e_1, e_2, e_3).by the vector relation x = χ(X, t), such that:

$$\begin{cases} x_1 = X_1 e^t + X_3(e^t - 1) \\ x_2 = X_2 + X_3(e^t - e^{-t}) \\ x_3 = X_3 \end{cases}$$

a) Show that the Jacobian is non-zero.
b) Write the inverse equations of the motion defined by : $X = \chi^{-1}(x, t)$.
c) Provide expressions for velocity and acceleration in both Lagrangian and Eulerian descriptions.

Exercise N° 2 :

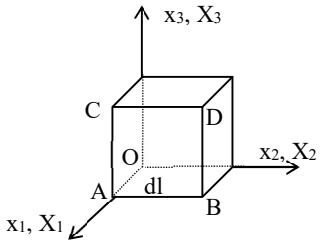
The motion of a continuous medium is defined in an orthonormal frame R=(O,e_1, e_2, e_3).by the vector relation x = χ(X, t), such that:

$x_1 = X_1$; $x_2 = X_2 + t^2 X_3$; $x_3 = X_3 + t^2 X_2$

1) Write the inverse equations of the motion defined by $X = \chi^{-1}(x, t)$.
2) Provide expressions for velocity and acceleration in both the Lagrangian and Eulerian descriptions.
3) Determine the velocity and acceleration at time t = 2 s for:
   a) The particle with coordinates (1, 2, 1) at the initial state (t = 0)
   b) The particle with coordinates (1, 0, 1) at the current state (t = 2 s)

At time t=0, consider a small cube of side length dl defined within a direct orthonormal coordinate system. R=(O, e_1, e_2, e_3,).

4) Determine the matrix of the Transformation gradient tensor.
5) Determine the matrix of the (Cauchy-Green) stretch tensor.
6) Determine the matrix of the (Green-Lagrange) strain tensor.
7) Determine and plot the transformed state of face ABCD of the cube at time t = 0.1 s.
8) Determine the strain E(u0, u0) in the direction AD.



Exercise N° 3 :

In the space referred to the coordinate system (O, e_1, e_2, e_3), a continuous medium occupies the domain at time t=0.

$-1 < X_1 < +1$ $-1 < X_2 < +1$ $0 < X_3 < 1$

The medium undergoes a deformation between time 0 and t such that the Lagrangian representation of the transformation is given by:

$x_1 = (1+\omega t)\, X_1 \cos(\omega t)$
$x_2 = X_2 + (1+\omega t)\, X_1 \sin(\omega t)$ (ω is a constant)
$x_3 = X_3$

Determine in the coordinate system (O, e_1, e_2, e_3) :

a) the (Cauchy-Green) stretch tensor (C)
b) the (Green-Lagrange) strain tensor (E)
c) The linearized strain tensor in the case where the parameter ω is small.