# Mecánica Clásica
# Tarea 04: Cuerpo Rígido I: Cinemática

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Nombre del Estudiante: _____

**Problema 1** *Euler angles quantities*

Demostrate the following:

(a) The expresion of the rotation angle $\Phi$ (single rotation) in terms of the Euler angles ($\theta$, $\phi$, $\psi$):

$$\mathrm{Cos}\frac{\Phi}{2} = \mathrm{Cos}\frac{\phi+\psi}{2}\mathrm{Cos}\frac{\theta}{2}.$$

(b) The components of the angular velocity along the inertial space set of axes in terms of the Euler angles:

$$\omega_x = \dot{\theta}\mathrm{Cos}\phi + \dot{\psi}\mathrm{Sen}\theta\mathrm{Sen}\phi,$$
$$\omega_y = \dot{\theta}\mathrm{Sen}\phi - \dot{\psi}\mathrm{Sen}\theta\mathrm{Cos}\phi,$$
$$\omega_z = \dot{\psi}\mathrm{Cos}\theta + \dot{\phi}.$$

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**Problema 2** *Coriolis deflection for vertical movement*

A particle is thrown up vertically with initial speed $v_0$, reaches a maximum height and falls back to ground. Show that the Coriolis deflection when it again reaches the ground is opposite in direction, and four times greater in magnitude, than the Coriolis deflection when it is dropped at rest from the same maximum height.

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**Problema 3** *Coriolis deflection for horizontal movement*

A projectile is fired horizontally along Earth's surface. Show that, to a first approximation, the angular deviation from the direction of fire resulting from the Coriolis effect varies linearly with time at a rate $\omega\mathrm{Cos}\,\theta$, where $\omega$ is the angular frecuency of Earth's rotation and $\theta$ is the co-latitude (measured from the rotation axis). The direction of deviation being to the right in the northern hemisphere.

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**Problema 4** *Foucault pendulum*

The Foucault pendulum experiment consists in setting a long pendulum in motion at a point on the surface of the rotating Earth with its momentum originally in the vertical plane containing the pendulum bob and the point of suspension.
Show that the pendulum's subsecuent motion may be described by saying that the plane of oscillation rotates uniformly $2\pi \mathrm{Cos}\,\theta$ radians per day, where $\theta$ is the co-latitude. What is the direction of rotation? The approximation of small oscillations may be used, if desired.

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**Problema 5** *Bug on a wheel*

A wagon wheel with spokes is mounted on a vertical axis so it is free to rotate in the horizontal plane. The wheel is rotating with angular speed of $\omega = 3.0$ rad/s. A bug crawls out on one of the spokes of the wheel with a velocity of 0.5 cm/s holding on to the spoke with a coefficient of friction $\mu = 0.30$. How far can the bug crawl along the spoke before it starts to slip?

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