Problems

November 5, 2018

1. An airplane of mass $m = 2000\ kg$ flying near the surface of the earth ($let\ r = 6400\ km$) at latitude $\alpha = 45°$ (so that the angle from the north pole, θ, is $\frac{\pi}{2} - \alpha = 45°$) flies due south. What force (direction and magnitude) must be exerted to offset the centrifugal force? What force (magnitude and direction) must be exerted to offset the Coriolis force?

2. Compute the moment of inertia of a rectangular planar sheet of sides a, b about an axis through one corner and perpendicular to the plane of the rectangle (this will be I_{33}, where the sheet lies in the xy plane).

3. Use the Euler equations to describe the motion of a spinning cylinder

   (a) A solid right cylinder of radius R and length L (volume $V = \pi R^2 L$) has mass M. Find the moment of inertia tensor about its center of mass.

   (b) Use your result to describe the torque-free motion of the cylinder. Suppose $L = 2R$ and the angular velocity ω about the long axis is large.

4. Find the moment of inertia tensor for a uniform sphere of radius R and mass M about its center.