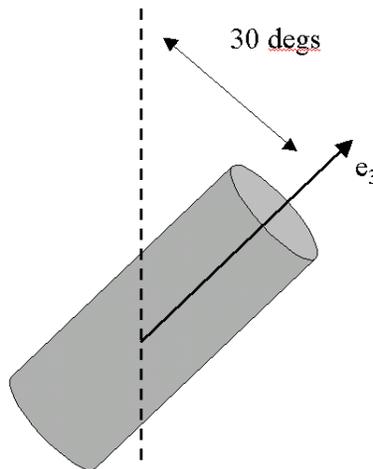


16.61 Homework Assignment #10

1. Assume that a satellite can be modeled as a homogeneous cylinder shown below with a mass $M = 200\text{kg}$, axial moment of inertia $5M$ ($\text{kg}\cdot\text{m}^2$) and transverse moment of inertia $20M$ ($\text{kg}\cdot\text{m}^2$). Initially the (*force free*) satellite is moving such that the component of angular velocity ${}^i\vec{\omega}^R$ parallel to the body axis of symmetry is 15 rev/hr and the nutation angle is 30° . Given this information, determine the following:



- (a) H_3 , H_T , and the total magnitude of H
 - (b) The precession rate and the spin rate.
 - (c) The magnitude of ${}^i\vec{\omega}^R$
 - (d) The body cone and space cone angles.
 - (e) Sketch the body and space cones for this system. In your sketch include ${}^i\vec{\omega}^R$, H , and the axis of symmetry of the satellite.
2. Consider a paddle-wheeler steam boat moving forward downstream on the Mississippi River. The captain has commanded a very sharp turn to the left to avoid the other boat. What direction does the boat lean (in roll) as a result of the gyroscopic effects of the paddle-wheel?

3. A proposed space station is closely approximated by four uniform spherical shells, each of mass m and radius r . The mass of the connection structure and internal equipment can be neglected. Station designed to rotate about its z -axis once every 4 sec, determine:
 - (a) The number n of complete cycles of precession for each revolution about the z -axis if the plane of rotation deviates only slightly from a fixed orientation.
 - (b) The period τ of the precession if the spin axis makes an angle of 20° with respect to the axis of fixed orientation about which the precession occurs.
 - (c) Draw the space/body cones for the condition in part (b).
4. Do problem 18.84 from Beer and Johnston *Vector Mechanics for Engineers*.