16.61 - Aerospace Dynamics Spring 2006
Sample Quiz 1

Version: 1.0
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Problem 1

A particle of mass m is constrained to move on a smooth circular hoop of radius l under the action of gravity, as illustrated in Figure 1. It is assumed that the circular hoop rotates with constant angular velocity of Ω about the vertical line. As illustrated in Figure 1, Frame A $\{a_1, a_2, a_3\}$ is an inertial reference frame with origin O and Frame B $\{b_1, b_2, b_3\}$ is a rotating frame fixed at the origin. The position of the partic in the B frame is $r_B = lb_1$. The angular velocity of B with respect ot A is $\omega^{B/A} = -\Omega a_1 + \dot{\theta} b_3$. Show that the equation of motion of the particle is

$$ml\ddot{\theta} + mg\sin\theta = ml\Omega^2 \sin\theta\cos\theta$$

where θ is the angular position of the particle from the vertical line and g is the gravitational acceleration. Reference: [1] Wie, Space Vehicle Dynamics and Control, Problem 1.12 (a), p 35, AIAA, 1998.

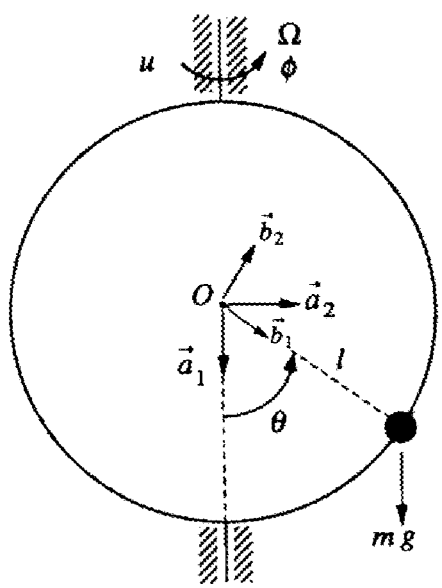

Figure 1: Particle on a rotating circular hoop. Ref: [1] Wie, Space Vehicle Dynamics and Control, Figure 1.6, p 36, AIAA, 1998.

Problem 2

A helicopter is moving vertically with speed 2ft/s and accelerations 5 ft/s^2. At the same time, the body of the body of the helicopter is rotating about a vertical axis with a constant angular velocity of 1.4 rad/s. The tail rotor (radius 2.5 ft) is rotating at a constant rate of 180 rad/s relative to the body. Find the absolute acceleration of a point at the tip of the tail rotor at the instant the blade is in the vertical position. The hub of the tail rotor is 25 ft behind the axis of rotation.

Problem 3

A variation on the theme of any of the merry-go-round Coriolis questions that we did in class. Specifically, calculation body acceleration if given inertial acceleration, OR calculation of inertial acceleration given body acceleration.

Problem 4

Determine the absolute acceleration of the point A on the rim of the disk as it passes the position shown.