GAM350/GAM450 Assignments

All the units are in the Internatian System (meter, kilogram, second). Justify all your steps. Do not derive formulas using numbers. Use a scientific text editor for formulas. Submit a single PDF for each assignment. All code must be indented properly or it will not be graded. No late assignments accepted.

1 Assignment 1 - Due Sep 18, 2012

1.1 Problem 1 (8 points)

Consider a particle (point like object) at position $\vec{p} = (1, 4, 10)$ at time $t = 0$ and velocity $\vec{v} = (0, 1, -2)$. The particle travels and hits a plane orthogonal to vector $\vec{n} = (-1, 1, 1)$ and passing through $\vec{q} = (5, 0, 0)$. When does the particle hit the plane? What if the particle has a radius r? Provide a formula that solves this problem for generic p, v, n, q, r.

1.2 Problem 2 (7 points)

At what angle do you have to fire a bullet so that it hits ground at a fixed given distance? Let $\vec{v}$ be the initial velocity of the bullet, θ the firing angle, g the gravity acceleration, and d the distance where it hits ground. Ignore friction. In case of friction, keeping everything else constant, would you increase or decrease the angle in order to center the same target?

2 Assignment 2 - Due Oct 2, 2012

2.1 Problem 1 (8 points)

One body is connected by a spring to a wall. You compress the spring to its maximum until the body touches the wall and then you let it go. What is the maximum velocity reached by the body? When does it happen? What is the maximum accelleration? When does it happen?

2.2 Problem 2 (7 points)

Use Cylon to implement the above system, measure the velocity and acceleration as function of time, verify your asnwers for problem 1.

3 Assignment 3 - Due Oct 16, 2012

3.1 Problem 1 (8 points)

Consider a rigid body consisting of massless sticks and massive spheres. When at rest the coordinates of the spheres are $(-1,-1,0)$, $(-1,1,-1)$, $(1,1,-1)$, $(1,-1,-1)$, $(0,0,2)$. The 5 spheres have masses $1,2,3,4,5$ respectively. What is the inertia tensor for the body? The body is initially at rest and subject to a torue $\vec{\tau} = (0,1,2)$ for 0.1 seconds only. What is the angular velocity of the body after 1h (assume no friction)? Around which axis is it rotating?

3.2 Problem 2 (7 points)

Implement the rigid body of problem 1 using Cylon and verify your findings. Plot the norm of the absolute velocity of each of its spheres relative to its center of mass.

4 Assignment 4 - Due Oct 30, 2012

4.1 Problem 1 (15 points)

Implement a simple flight simulator using Cylon. Load the airplane object file, assume the airplane is subject to gravity and a friction proportional but opposite to the speed of the airplane. Implement key bindings to control the airplane, rotate it (yaw, pitch, roll) and accellerate it. Describe your assumptions.

5 Final Project - Due Nov 20, 2012 (up to 40 points)

Improve the flight simulator. Allow two points of view (driver and inertial). Add random objects on the flight path (spheres or cubes) and collisions among the objects themselves and the objects and the airplane. Resolve all collisions.

6 Extra credit

For extra credit on final project generate explosions on collisions (+5 points), torque on collision (+5 points), water (+10 points). They must be implemented correctly to get extra points.

You will also get extra points for help improving lecture notes and Cylon code.