

# Report #6

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## Dynamic Simulation of Rotation

Simulate the rotation of a rigid cylinder in 3D space. Define class `RigidBody_Cylinder` as a subclass of `RigidBody`. Use appropriate values of geometrical and physical parameters of the cylinder. Apply torque vectors with different directions.

### Class `RigidBody_Cylinder`

First, we define the class `RigidBody_Cylinder` as a subclass of `RigidBody`. The class `RigidBody_Cylinder` has the height and radius of the cylinder as its properties. To calculate its inertia matrix, we use the formula for the inertia matrix of a cylinder. The inertia matrix of a cylinder is given by

$$I = \frac{1}{12}m \begin{pmatrix} 3r^2 + h^2 & 0 & 0 \\ 0 & 3r^2 + h^2 & 0 \\ 0 & 0 & 6r^2 \end{pmatrix} \quad (1)$$

where  $m$  is the mass of the cylinder, calculated by  $m = \rho\pi r^2 h$ ,  $r$  is the radius of the cylinder, and  $h$  is the height of the cylinder. With this equation, we can define our `RigidBody_Cylinder` class as follows:

```
classdef RigidBody_Cylinder < RigidBody
    properties
        r, h;
    end
    methods
        function obj = RigidBody_Cylinder (rho, r, h)
            obj@RigidBody(1, eye(3));
            m = rho*pi*r^2*h;
            Jz = (1/2)*m*r^2;
            Jx = (1/12)*m*(3*r^2 + h^2);
            Jy = Jx;
            J = diag([Jx, Jy, Jz]);
            obj.mass_and_inertia_matrix(m, J);
            obj.density = rho;
            obj.r = r;
            obj.h = h;
        end

        function draw(obj, pos, q)
            % this function is omitted for simplicity
        end
    end
end
```

## Simulation Results

We simulate the rotation of a cylinder with radius  $r = 2$ , height  $h = 6$ , and density  $\rho = 1$ . The external torque is defined as a function of time:

$$\tau(t) = \begin{cases} [12, 0, 0] & \text{if } t \leq 5 \\ [0, -12, 0] & \text{if } t > 5 \text{ \& } t \leq 10 \\ [0, 0, 0] & \text{if } t > 10 \end{cases} \quad (2)$$

The simulation results are shown in the following figures.

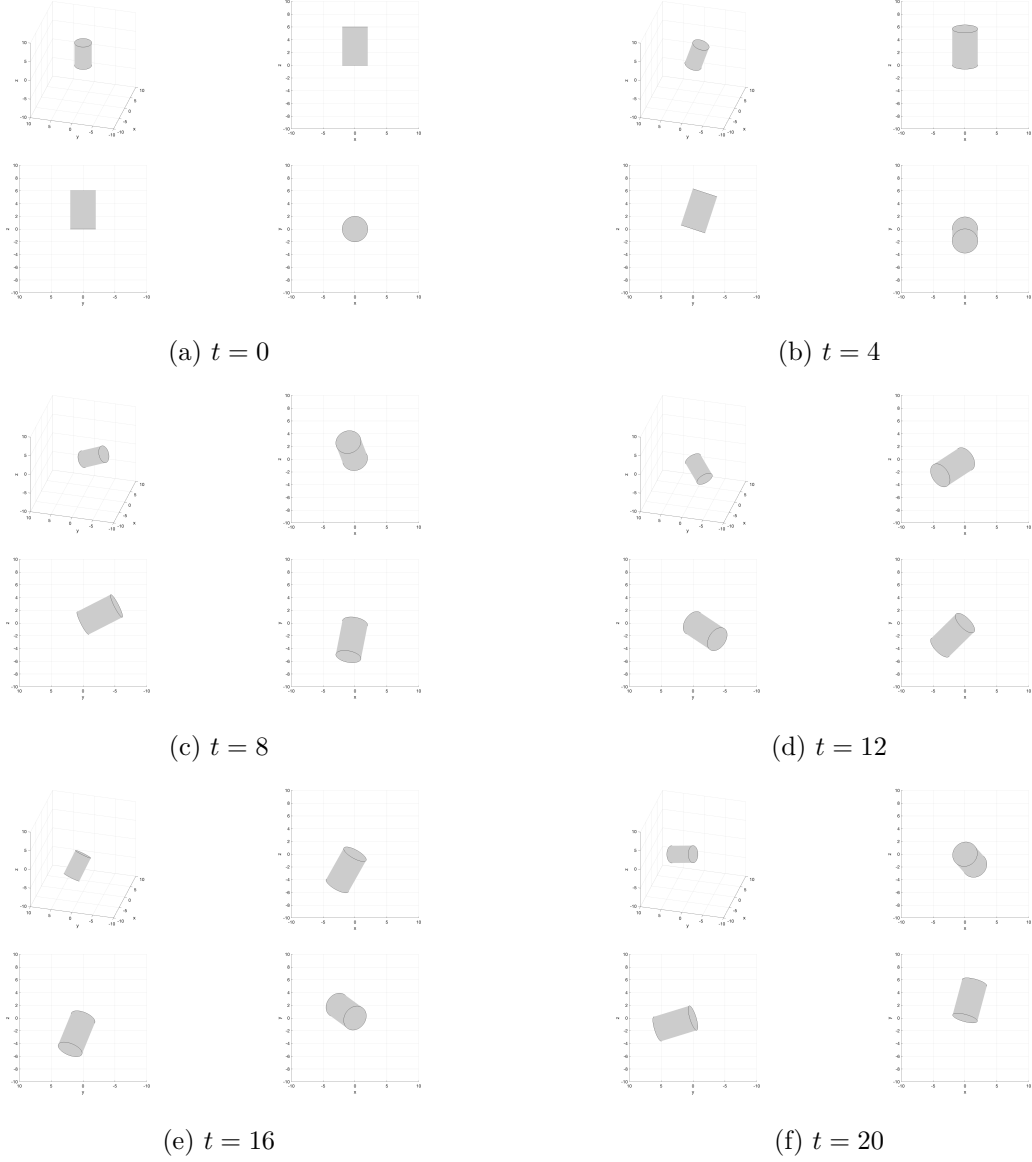


Figure 1: Simulation results of the rotation of a cylinder.

This video can be found at [https://youtu.be/vdpJ3pKb\\_bM](https://youtu.be/vdpJ3pKb_bM).