Sample Midterm

Simulation and Modeling (CSCI 3010U)

February 7, 2023 (70 min.)

Family name: _____

Given names: _____

Student number: _____

Question	Marks		
1	_____	/	10
2	_____	/	10
3	_____	/	10
4	_____	/	10
5	_____	/	10
6	_____	/	10
Total	_____	/	60

Instructions

- Write in pen.
- No need to use a calculator. Express your answers as fractions.
- Be happy.
- Read widely.
- Always pack sunscreen.
- Total pages: 10.

Question 1 [10 Marks]

Consider a ball with mass m that is dropped from a height of h meters. The ball hits the floor, which sits at height a meters. We assume that the ball moves under gravity g, pointing in the negative y-direction. Friction is magically absent.

Part A [10%]

Write down the state variables needed for this simulation.

Part B [40%]

Write down the Euler update rules for the state variables

Part C [20%]

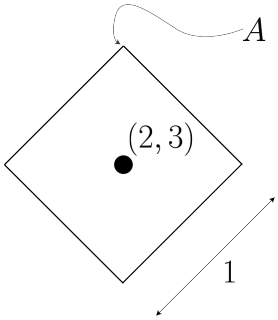
Devise a scheme to detect the collision with the floor. Also, how should we set up the collision response?

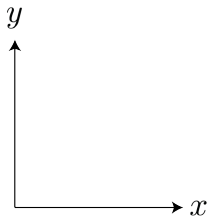
Part D [30%]

Compute the velocity of the ball at height k, where k is less than h.

Question 2 [10 marks]

Consider a 2D square as shown in the figure below. The square is sitting at location $(2, 3)$. The square is oriented at 45 degrees. Assuming that each side of the square is 1, what is the location of vertex A in the world coordinates.





Question 3 [10 Marks]

Define terminal velocity? Imagine you are observing an objecting falling to earth through the lens of a camera. How would you determine if the object has achieved terminal velocity. Be as specific as possible.

Question 4 [10 Marks]

Describe the difference between continuous systems simulation and discrete event simulations.

Question 5 [10 Marks]

Consider a 3D rigid object comprising N masses m_i, each sitting at location $\mathbf{p}_i$, where $i \in [1, n]$. Compute the center of mass for this object.

Question 6 [10 Marks]

What is the difference between Force and Torque? How are the two related?

End of exam.