

# Lab 3 (Earth and Moon)

## Simulation and Modeling (CSCI 3010U)

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Due back Oct. 6, 11:59 pm

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### Introduction

The goal of this lab is to simulate the moon orbiting around the earth. The provided Python code implements such a simulation. You are asked to ascertain if this simulation has any errors. Of course the simulation makes many simplifying assumptions; however, it shouldn't have any glaring errors. You are also asked to determine if the moon's orbit is stable. If the orbit is unstable, one of two things will happen. Either the moon will escape earth's gravitational pull, or it will come crashing down. Neither options are desirable. If the orbit is unstable, can you find a way to make it *more* stable?

### Model

We assume that earth and moon each exerts an attractive force on each other that can be determined as follows:

$$F = G \frac{m_{moon} m_{earth}}{r^2},$$

where  $r$  is the distance between the earth and the moon. Force acts along the line joining two centers.  $G$  is *gravitational constant*. Relevant quantities are listed in the Python code.

### Tasks

- This simulation is using Euler method for solving the differential equations. Change the code such that it now uses RK4 method for solving the differential equations.
- Determine if the moon's orbit is stable.
- If it is unstable, suggest a fix.

### Submission

Via Blackboard.

- Python file that replaces Euler with RK4
- A one page report describing your fix to achieve a stable orbit. This should also include your reasons about why you think your fix achieves the desired result.