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CSCI 3010U Lab 3 Report

Once the code was changed to use the RK4 method to solve the differential equations, the orbit seemed to be more stable compared to the Eulor method with an initial moon velocity of 1000 m/s. After closer observation of the radial distance values, when setting the initial velocity of the moon to 1000 m/s, it did not seem stable and in time the moon would probably get sent flying out or in.

Observations:

Initial Moon velocity set low:

- The Moon would orbit few times and then come crashing into the Earth.
- The centrifugal force would be less than the gravitational force exerted on the Moon by the Earth.

Initial Moon velocity set high:

- The Moon would orbit and the Earth and then eventually it would fly away.
- The centrifugal force would be greater than the gravitational force exerted on the Moon by the Earth.

From the initial observations I determined that to keep the Moon at a stable orbit, the net force in the radial direction must be 0. Therefore, the initial velocity must be determined, which would make the centrifugal force and the gravitational force exerted on the Moon by the Earth equal. From this we can determine the ideal initial velocity for the Moon.

Calculations:

$F_{net} = F_C + F_G$ where we will set the radially outward direction as positive, and inward as negative.

When we set F_{net} to 0, we get:

$F_C = -F_G$ where $F_C = \frac{m_{Moon}v^2}{r}$ and $F_C = -\frac{Gm_{Earth}m_{Moon}}{r^2}$

- ➔ $\frac{m_{Moon}v^2}{r} = \frac{Gm_{Earth}m_{Moon}}{r^2}$
- ➔ $v^2 = \frac{Gm_{Earth}}{r}$
- ➔ $v = \sqrt{\frac{Gm_{Earth}}{r}}$

Conclusion:

Since we have all values for G, m_{Earth}, and the initial radial distance, r, we can set the initial tangential velocity of the Moon to equal this final equation and we get a stable orbit.