Orbital Patterns of Martian Moons

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Outline

- Model Goals
- Problem Overview
- Calculations
- Conclusion
- Sources & Questions

Model Goals

- The goal of our project is to model the interactions of the moons Phobos & Deimos with the planet Mars due to Gravity
- The program we created will simulate an objects path given some initial conditions and a gravitational constant.
- The simulation is run for each moon to simulate their interactions with the planet.

Problem Overview

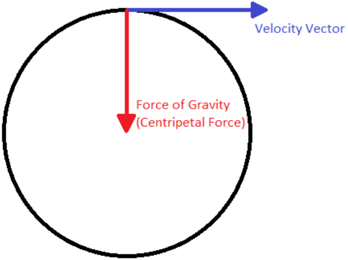


Figure: Orbital Diagram

Calculations

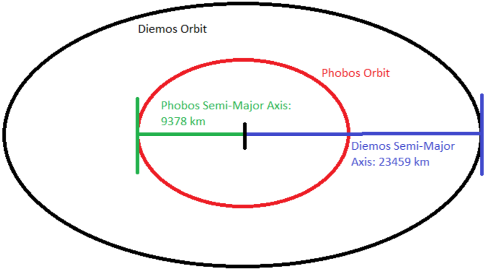
Before performing the calculations to determine an objects new position in space, we must have some initial conditions to go off of. The initial conditions that need to be set are:

- Gravitational Constants for Phobos and Deimos
  - Normalized for each moon
- Initial Position (X and Y Positions)
- Initial Velocity (X and Y Velocity Vectors)
- Time
  - Time Step
  - Initial Time
  - Orbital Period (Max Time)

Calculations - Initial Position

- We set the initial position of each moon to be at the semi-major axis of their orbit.
- The semi-major axis of each moon as defined by Nasa are:
  - Phobos: $9378km \rightarrow 9.378x10^6m$
  - Deimos: $23459km \rightarrow 23.459x10^6m$

Figure: Semi-Major Axis Illustration



Calculations - Gravitational Constants

The calculations will be simplified if we can normalize the gravitational constant for each moon.

Phobos

- $G = 6.683*10^(-11)N*m^2*kg^{-2}$
- $G = 4\pi^2 * \frac{R^3}{Year_{Phobos}*M_{System}}$
- $R = 9.378x10^6 m$
- $M_{System} = M_{Mars} + M_{Phobos}$
- $M_{Phobos} = 10.6 * 10^{15} kg$
- $Year_{Phobos} = 27553.82s$
- $Gravity_{Phobos} = 4.2887 * 10^{13}$

Deimos

- $G = 6.683*10^(-11)N*m^2*kg^{-2}$
- $G = 4\pi^2 * \frac{R^3}{Year_{Moon}*M_{System}}$
- $R = 23.459x10^6 m$
- $M_{System} = M_{Mars} + M_{Moon}$
- $M_{Diemos} = 2.4 * 10^{15} kg$
- $Year_{Diemos} = 109074.81s$
- $Gravity_{Phobos} = 4.283910^{13}$

Calculations - Initial Velocity

Now that we have normalized the gravitational constants, determining each moons initial velocity

Phobos

- $F = ma$
- $F_{Net} = \frac{M_{Phobos} * v^2}{R}$
- $F_{Gravity} = \frac{G_{Phobos}}{R^2}$
- $F_{Net} = F_{Gravity}$
- $V_{Phobos} = \sqrt{\frac{Gravity_{Phobos}}{R_{Phobos}}}$

Deimos

- $F = ma$
- $F_{Net} = \frac{M_{Deimos} * v^2}{R}$
- $F_{Gravity} = \frac{G_{Deimos}}{R^2}$
- $F_{Net} = F_{Gravity}$
- $V_{Deimos} = \sqrt{\frac{Gravity_{Deimos}}{R_{Deimos}}}$

Calculations - Time

- Time Step
  - A time step ($deltaTime = dt$) will be 1 second increments ($dt = 1.0s$)
- Initial Time
  - $t = 0.0s$
- Orbital Periods are constants retrieved from Nasa
  - Phobos: $tmax = 27553.824s$
  - Deimos: $tmax = 109074.816s$

Beamer is very easy to learn even if you are completely new to LaTeX. There are many different things you can do with the Beamer class...you can even embed video into your slides!

There are many, many, many good sources available on the web for LaTeX. Wiki Books on LaTeX is a great place to start. Using the Beamer class is pretty redundant...after making a few slides, you'll get used to it pretty quick.

I know this guide was very short, but the basics of presentations are pretty much the same regardless if you are using powerpoint or LaTeX. If you know LaTeX then you know that math looks best in this typeset language...so all you need to know is how to basically create one slide that may inlcude bullet points, pictures, and columns.

Once you know these things, than you can format your Beamer slides any way you want. The best way to learn is to try it yourself. I hope this guide will help get you started.