POLITECNICO
MILANO 1863

GENERAL INSTRUCTIONS

Project

Auxiliar functions available in WeBeep

- For the assignments, you may use the auxiliar MATLAB functions **available in WeBeep**:
  - `astroConstants`: Use it to retrieve common astrodynamics constants (both assignments).
  - `lambertMR`: Use it for solving each Lambert arc (Assignment 1).
  - `uplanet`: Planets' ephemeris (**don't propagate the planets' orbits yourself**).
    - In Assignment 1, use it to compute the ephemerides of departure and flyby planets.
    - In Assignment 2, use it to compute the Sun-Earth position vector for SRP evaluation.
  - `ephMoon`: Analytical ephemeris of the Moon.
    - In Assignment 2, use it to compute the Moon position for third-body perturbation evaluation.
  - `ephNEO`: Ephemerides of several Near-Earth Objects.
    - In Assignment 1, use it to compute the ephemerides of arrival NEO.
  - **timeConversion.zip**: Compressed folder with several time conversion routines

Teamwork

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As in a **Mission Analysis team** at **ESA**, you will also work in a group:

- Members of the group must **cooperate**: you are advised to share the work among the team, but **everyone is responsible for all the work done in the project**. This means the work of the team must be checked by the whole team.
- Make decisions towards design solutions based on numerical/analytical/physical evidence and analyses: you must always be able to **motivate your design choices**. *You are supposed to perform the preliminary mission analysis of a real mission*.
- During the final review (oral presentation), **any team member can be questioned about any part of the work**.

Project deliverables and deadlines

Overview

- Project evaluation includes:
  - **Deliverables** (1 submission per group)
    - **Project report**: A single PDF report on the assignments, of maximum **15 pages (total no exceptions)**
    - **Presentation slides**
    - **Simulation codes and results**
    - **Numerical results**, to be submitted via a form
  - **Peer evaluation**
  - **Oral presentation (final review)**
    - **15 minutes** followed by questions about the assignments and the theory of the course
    - All team members must participate in the oral presentation
    - Any student can be questioned about any part of the work

Project deliverables and deadlines

Submission procedure and deadlines

- The deliverables must be submitted through **WeBeep**
  - Submit a **single ZIP file** with **report, slides, and code**, named "`OrbitalMech_group_nnnn.zip`", where `nnnn` is the group ID (e.g., `OrbitalMech_group_2242.zip`).
  - WeBeep **submission file limit is 250MB**. Larger submissions sizes are not allowed (nor needed).
  - **Numerical results for specific questions** and **peer review** submitted via forms in WeBeep.
  - Submissions via any other means will not be considered.
  - Changes to the deliverables after the deadline will not be considered.
- Deadlines:
  - **Deliverables must be submitted by 7 January 2023**.
    - Delivering the project is a must condition for the oral presentation and attending the written exam.
    - The delivery activity in WeBeep closes automatically on 7 January at 23:59.
  - **Oral presentation**
    - Dates will be available during the Winter, Summer and September exam sessions. They will be notified at the beginning of each session.
    - To be done before or within the same exam session (winter/summer/autumn) when the written is done.

Project deliverables and deadlines

Report

- **Single PDF of maximum 15 pages (both assignments in the same report).**
- Include a **front page** with:
  - Title,
  - Group number, academic year,
  - For each member: full name, matriculation number, and person code.
- The report should contain **explanations, data, figures, and tables supporting your design process and final solution.**
  - You may follow the structure in the 'Mission analysis outputs' slides.
  - **Properly indicate the units of all numerical data**.
  - **Include labels, legends and titles/captions in all figures**.
  - No need to include theory, but properly introduce/reference all the formulas and models you use.
  - Include a 'References' section with a list of all the sources you consulted, and cite them in the text where appropriate.
  - Properly credit all images taken from other sources.

Project deliverables and deadlines

Code

- The codes for both assignments must be included inside a folder named `Code`, with **two separate subfolders for each assignment** as follows:
  - **Assignment 1**: Subfolder `Code\Assignment1\` containing:
    - `InterplanetaryMission_group_N.m`: main script that reproduces your results (`N` is the group ID).
    - `Code\Assignment1\functions\`: subfolder with **all the other functions you developed** for the first assignment.
  - **Assignment 2**: Subfolder `Code\Assignment2\` containing:
    - `PlanetaryMission_group_N.m`: main script that reproduces your results (`N` is the group ID).
    - `Code\Assignment2\functions\`: subfolder with **all the other functions you developed** for the second assignment.
- No need to upload the functions we provide to you in WeBeep, unless you modified them.

Project deliverables and deadlines

Code headers

- Each code file must include a **header** detailing:
  - Inputs and outputs (specify dimensions and units),
  - Authors,
  - Basic usage information

```
function dy = ode_2bp( t, y, muP )
%ode_2bp ODE system for the two-body problem (Keplerian motion)
%
% PROTOTYPE:
%   dy = ode_2bp( t, y, mu )
%
% INPUT:
%   t[1]        Time (can be omitted, as the system is autonomous)  [T]
%   y[6x1]      Cartesian state of the body ( rx, ry, rz, vx, vy, vz ) [ L, L/T ]
%   muP[1]      Gravitational parameter of the primary [L^3/T^2]
%
% OUTPUT:
%   dy[6x1]     Derivative of the state  [ L/T^2, L/T^3 ]
%
% CONTRIBUTORS:
%   Student 1
%   Student 2
%
% VERSIONS
%   2020-11-19: First version
%
```

Project deliverables and deadlines

Final review

The **final review** will take the form of an oral presentation, followed by several questions:

- **Maximum 15 minutes for both assignments combined (not including the questions).**
- All team members have to participate in the oral presentation.
- **Any student can be questioned about any part of the work.**
- Questions can be related to the **report contents, design process, underlying theory, and final results.**

References

- Lecture notes and lab slides.

- Spacecraft orbital elements available at:
  - Space-Track: https://www.space-track.org
  - Celestrack: https://celestrak.com/NORAD/elements/
  - NASA/JPL's HORIZONS: https://ssd.jpl.nasa.gov/horizons/app.html

- Books:

  - D. Vallado, *Fundamentals of Astrodynamics and Applications, 4th Edition*, Springer, 2007, ISBN-13 978-0387718316.
    Chapters 8 and 9 (very detailed).
  - R. H. Battin, *An Introduction to the Mathematics and Methods of Astrodynamics, Revised Edition*, AIAA Educational Series, Reston, 1999.
    Chapter 10 (Gauss and Lagrange equations derivation).
  - H. Curtis, *Orbital Mechanics for Engineering Students, Second Edition*, Butterworth-Heinemann, 2009, ISBN-13 978-0123747785.
    Chapter 12 (introduction to orbit perturbations).