Course summary of
AE 8803 – Special Topics: Hamiltonian Mechanics in Space Dynamics
Planned to be offered in Fall 2023

1. Description

This introductory course will explore the concepts and applications of Hamiltonian Mechanics in Space Dynamics. This course will consist of three parts. The first part will be familiar with Hamiltonian Mechanics. We will start by briefly reviewing Lagrangian Mechanics to connect it with Hamiltonian Mechanics. Key concepts will include Hamiltonian, cannonical equations, and canonical transformation. The second part will be to discuss the N-body problem and apply Hamiltonian Mechanics to it. Finally, we will discuss numerical integrators that conserve symplectic structures in Space Dynamics, which is based on Hamiltonian Mechanics. This numerical integrator concept will be applied to quantify the time evolution of space dynamics.

2. Planned course schedule (subject to change)

Each topic consists of up to five subtopics, each of which may be covered in multiple lectures or skipped, depending on progress.

- Review of N-body problem
- Lagrangian Dynamics
    - D'Alembert's principle
    - Hamilton's principle
    - Applications to multi-body system
    - Applications to distributed system
    - Practices
- Hamiltonian Dynamics
    - Canonical equation
    - Poisson's brackes
    - Canonical transformation – Poisson's brackets
    - Canonical transformation – Symplectic structures
    - Practices
- Full Multi-Body Dynamics
    - Concepts of full multi-body problem
    - Mathematical formulation
    - Full two-body problem
    - Restricted full-three body problem
    - Practices
- Symplectic Integrator
    - Generation function method
    - Implicit Runge-Kuta method
    - Explicit method
    - Practices

3. Syllabus

The course syllabus will be provided once all the logistics are determined including the time and location.