Asian Institute of Technology
School of Engineering and Technology

AT76.9039 *Spacecraft Dynamics and Control* **1(1-0)** **Semester: January**

Course Objective: This course provides the principles of spacecraft dynamics and basic control technics of spin-stabilized satellites. It includes fundamental mathematics and dynamics which are necessary to understand the spacecraft's behavior in space. The objectives of this course are to give a basic working knowledge of vector algebra and matrices as well as the rigid-body dynamics and control theory.

Learning Outcomes:

The students on the completion of the course would be able to:

1. Obtain a basic knowledge of vector algebra and matrices.
2. Critically evaluate and apply principles of spacecraft dynamics and control techniques.
3. Explain the attitude maneuvers of rigid spacecraft.
4. Control the spin-stabilized satellites.

Prerequisite: None

Course Outline:

I Introduction

II Mathematical Preparation
1. Coordinate System
2. Vector
3. Dyadic
4. Matrix
5. Direction Cosine Matrix

III Basic Kinematics
1. Motion and Degrees of Freedom
2. Finite Rotation
3. Infinitesimal Rotation
4. Parametric Expression of Attitude
5. Angular Velocity and Angular Acceleration
6. Translational Velocity and Acceleration
7. Relationship between Angular Velocity and Time-Derivative of Attitude Parameters

IV Basic Dynamics
1. Dynamics of a Particle

2. Dynamics of a Rigid-Body
3. Stability of Dynamical System
4. Basic of Spin-Satellite Dynamics

V Dynamics and Control of Spin-Stabilized Satellite
1. Passive Spin Stability
2. Active Control
3. Attitude Determination

Laboratory Session(s): None

Learning Resources:

Textbooks: Lecture notes, handouts and other ancillary learning resources will be provided.

Reference Books:

Koji Takahashi, Shigemune Taniwaki, and Takuya Kanzawa:
Spacecraft Dynamics and Control, JAXA Dynamics & Control Unit, Japan, 2004

Marshall H. Kaplan:
Modern Spacecraft Dynamics & Control, John Wiley & Sons, New York, USA, 1976

Roger R. Bate, Donald D. Mueller, and Jerry E. White:
Fundamentals of Astrodynamics, Dover Publications, USA, 1971

Donald T. Greenwood:
Principles of Dynamics, Prentice-Hall, New Jersey, USA, 1965

Journals and Magazines:

Journal of Guidance and Control, Aerospace Research Central

Others:

P. W. Linkins:
Dynamics and Control of Flexible Space Vehicles, Volume 105592 Issue 32, Part 1329 of JPL technical report NASA contractor report, Jet Propulsion Laboratory, California Institute of Technology, 1969

Teaching and Learning Methods:

1. **Lectures**: Students will receive lecture notes and weekly lecture schedule at the beginning of the course. They will be requested to read the lecture notes before coming to the class.
2. **Exercises**: In order to deepen the understanding, the instructor sometimes brings exercises or home works.

Time Distribution and Study Load:

Lecture: 15 Hrs
Self-study: 45 Hrs

Evaluation Scheme:

Mid-semester exam (closed book) : 40%
Final exam (closed book): 50%
Exercises or home works: 10%

In the examination, "A" would be awarded if a student shows excellent and insightful understanding of key concepts and techniques through the examinations and exercises; "B" would be awarded if a student shows a good understanding of all given topics and able to implement basic techniques; "C" would be given if a student meets below average expectation on both knowledge and skills; "D" would be given if a student does not meet basis expectations in understanding the topics and issues presented in course.

Instructor(s): Dr. Tai Nakamura/ Visiting Faculty